AD-752 228

OAO, A-2 (ORBITING ASTRONOMICAL OBSERVATORY A-2) MEASUREMENTS OF THE ULTRAVIOLET AIR-GLOW

Edward S. Fishburne, et al

Grumman Aerospace Corporation

Prepared for:

Air Force Cambridge Research Laboratories
Advanced Research Projects Agency

30 September 1972

AFCRL-72-0318

AD752228

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Grumman Aerospace Corporation
Bethpage, New York 11714

Contract No. F19628-71-C-0129
Project No. 8692

FINAL REPORT
March 1971 - September 1972

30 September 1972

Contract Monitor: Arthur K. Holmes
Optical Physics Laboratory

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ARPA Order No.:	1366
Program Code No.:	1E50
Name of Contractor:	Grumman Aerospace Corporation
Effective Date of Contract:	1 February 1971
Contract No.:	F19628-71-C-0129
Principal Investigator and Phone No.:	Dr. Edward S. Fishburne (516) 575-2229
AFCRL Project Scientist and Phone No.:	Arthur K. Holmes (616) 861-2952
Contract Expiration Date:	30 April 1972

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DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Grumman Aerospace Corporation Bethpage, New York 11714	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

OAO, A-2, MEASUREMENTS OF THE ULTRAVIOLET AIRGLOW

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

Scientific Final March 1971-September 1972 Approved: 25 Sept. 1972

5. AUTHOR(S) *(First name, middle initial, last name)*

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Donald L. Moyer
Charles R. Waters
Barnett S. Green

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
30 September 1972	71	21

8a. CONTRACT OR GRANT NO. F19628-71-C-0129 b. PROJECT, TASK, WORK UNIT NOS. 8629 n/a n/a c. DOD ELEMENT 62301D d. DOD SUBELEMENT n/a	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* AFCRL-72-0318

10. DISTRIBUTION STATEMENT

Approved for Public Release; distribution unlimited.

11. SUPPLEMENTARY NOTES Details of illustrations in this document may be better studied on microfiche	12. SPONSORING MILITARY ACTIVITY Air Force Cambridge Research Laboratory (OP) L.G. Hanscom Field Bedford, Massachusetts 01730

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DD FORM 1473 1 NOV 65

Unclassified
Security Classification

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Airglow						
Earth Limb						
Nonthermal emissions						
Ultraviolet						
Atmosphere						
Radiation						

iB

Unclassified

Security Classification

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ABSTRACT

The term airglow is commonly used to describe nonthermal emissions not correlated with magnetic disturbances in the upper atmosphere. The study of this radiation provides information on the nature of the upper atmosphere, as well as clues to the physical processes occurring at very high altitudes. The spectral region below 3000Å is one of the most informative wavelength intervals, but the opacity of the atmosphere in this part of the spectrum prevents adequate measurement of ultraviolet emissions except by rocket and satellites. Until recently, most measurements were restricted to rocket flights at high altitudes, although a limited amount of information was obtained by several satellites in the OGO series, in particular, OGO-4 (Refs. 1-5).

To obtain more information about the earth's ultraviolet airglow, we undertook an investigation to measure the dark and sunlit earth using the Wisconsin Experiment Package (WEP) photometers of the Orbiting Astronomical Observatory A-2. The first series of measurements were concerned with the magnitude of the emitted radiation. Based on findings indicated by these measurements, we began concentrating on measurements of the earth limb. The small field of view of the WEP package has a fine spatial resolution, providing a detailed picture of the ultraviolet radiation in the earth's limb. Our measurements used the 2980, 2460, 2380, 1920, 1500, 1380, and 1250Å filters of the WEP stellar photometers.

The measurements obtained on the earth's limb represent the most complete coverage known to the authors. In addition, measurements in selected spectral regions provide the first information available on these regions and confirm observations by previous investigators. Finally, our experimental results tend to substantiate the theory that the dayglow in the 1300-1800Å region is primarily due to photoelectron excitation of molecular nitrogen.

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INTRODUCTION

Airglow and auroras have been subjects of considerable research during the past century. The most comprehensive analysis is that given by Chamberlain (Ref. 6), which contains more than 1600 references, compiled through 1959, to the literature. Most of these references concern ground observations of the visible airglow. Due to atmospheric absorption, however, measurements of ultraviolet emissions of the upper atmosphere have been limited to rocket and satellite observations. Tables 1-3 summarize the important ultraviolet experiments flown since 1963.

The most important features of the earth's airglow below 2000Å are the Lyman alpha emissions of atomic hydrogen at 1216Å and the emissions from the 1302, 1305, and 1306Å triplet of atomic oxygen. The Lyman alpha emission is produced by the resonance scattering of the Sun's Lyman alpha line, the strongest emission line in the solar spectrum. Most of the early rocket measurements (Ref. 7) concentrated on this particular feature. A long term study of the Lyman alpha corona was made by the Naval Research Laboratory Experiment, using OGO-4 (Ref. 4). From these measurements, Meier developed a detailed description and theory of the Lyman alpha geo-corona. The atomic oxygen lines, including the 1356Å line, have been studied thoroughly in the past few years (Refs. 8-10). It appears that these emissions of atomic oxygen are produced by photoelectron excitation. This mechanism also appears to produce the weaker emissions from atomic nitrogen at 1200, 1493, and 1744Å.

Barth (Ref. 2) has shown that the dominant radiation between 1358 and 1700Å is that due to the Lyman-Birge-Hopfield, the Birge-Hopfield, and the Vergard-Kaplin bands of molecular nitrogen. Theoretical investigations by Barth and by Green (Ref. 9) indicate that the emissions from these bands appear to be produced also by photoelectron excitation. The other major feature of the ultraviolet dayglow is the gamma bands of nitric oxide that are observed in resonance fluorescence (Ref. 11).

Measurements of the earth's dayglow (between 1700 and 3000Å) agree very well with calculations based on Rayleigh scattering, including absorption by ozone and absorption by molecular oxygen. We have indicated in Fig. 1 our calculation of the earth dayglow, which would result from first order Rayleigh scattering for a spherical atmosphere in the region between 1000 and 2000Å. The actual magnitude of the earth's dayglow will depend on the values

Table 1

OBSERVATIONS OF THE ULTRAVIOLET DAYGLOW

Reference	Wavelength Region	Quoted Measurement	Earth Radiance w/cm^2 - Ster - u	Comments
Friedman, Rawcliffe & Meloy - 1963	2450 - 2850 Å	2×10^{-5} w/cm^2-Ster-u	2×10^{-5}	Satellite measurement Radiometer with λ_c = 2550Å solar angle = 49° FOV = 1.2×10^{-4} Ster = .7° Sens. = 5×10^{-6} w/cm^2 - Ster - u
Hennes, Fowler Dunkelman 1964	2000 - 2700 Å	(.4-2) erg/sec-cm^2-ster -100 Å	$(.4-2) \times 10^{-4}$	Rocket flight 2 photometers λ_c = 2200 Å $\Delta\lambda$ = 230 Å λ_c = 2600 Å $\Delta\lambda$ = 100 Å Solar angle = 22°
Barth 1964	1500-3200 Å	2 KR at 2155 Å	1.47×10^{-7}	Aerobee - Spectrometer Altitude - 75 - 114 Km Sun angle = 60° Resolution = 10 Å γ bands of NO most prominent feature - Produced by Resonant Scatt.
Fastie Crosswhite & Heath 1964	1216 Å 1304 Å 1356 Å	13 Kr 7 Kr .4 Kr	100×10^{-6} 5.03×10^{-7} 2.76×10^{-8}	Aerobee Attitude - 210 km max. Resolution = 17 Å Peak in 1304 at 190 km Peak in 1356 at 135 km
Rawcliffe & Elliott 1966	2000 - 3200 Å	$(.2 - 9.5) \times 10^{-10}$ w/cm^2-ster-Å	$(.2 - 9.5) \times 10^{-6}$	
Moos & Fastie 1967	1216 Å 1304	3.6 Kr at 152 km 110 R	3.14×10^{-7} 8.95×10^{-9}	Rocket observation Sun elevation = -14° Twilight condition
Pearce 1969	2070 - 2370 Å	2155 Å 10 kR at 60 km 1 kR at 95 km	6.15×10^{-7} 6.15×10^{-8}	Rocket observation Altitude - 60-95 km Twilight condition Sun zenith = 92° Resolution = 12 Å (1,0) band of NO Most prominent

Table 1

OBSERVATIONS OF THE ULTRAVIOLET DAYGLOW - (Continued)

Reference	Wavelength Region	Quoted Measurement	Earth Radiance w/cm^2 - Ster - μ	Comments
Barth & Mackey **1969**	1150 - 3350 Å	1216 Å = 30 kR/20 Å 1304 Å = 20 kR/20 Å 1356 Å = 2 kR/20 Å 2550 Å = 30 kR/20 Å	1.95×10^{-6} $1.[illegible] \times 10^{-6}$ 1.17×10^{-7} 9.56×10^{-7}	OGO IV - Spectrometer Sun zenith = 0° Resolution = 20 Å
Chubb & Hicks 1970	1050 - 1350 Å 1350 - 1550 Å	1216 Å = 26 kR 1304 Å = 15 kR 2.5 kR	2.27×10^{-6} 1.22×10^{-6} 1.37×10^{-8}	OGO IV - No protoionization Chamber FOV = 65° 40'
Barth & Schaffner 1970	1150 - 3350 Å	1304 Å - 36.2 kR 1356 Å - 2 kR 1384 Å - 1.2 kR	2.21×10^{-6} 1.17×10^{-7} 6.90×10^{-8}	OGO IV - Spectrometer Resolution = 20 Å Sun zenith = 31°

Table 2

OBSERVATIONS OF THE ULTRAVIOLET NIGHTGLOW

Reference	Wavelength Region	Quoted Measurement	Earth Radiance w/cm^2 - Ster - u	Comments
Stecher 1965	1500 - 3500	20-100 R/Å	$(1.27 - 6.3) \times 10^{-5}$	Aerobee 4 spectrometers Resolution = 50 Å Max. radiation received at 92.7 km at 3000 Å through horizon.
Hemmes	2300 - 3800	Avg. = .75 R/Å	3.978×10^{-7}	Rocket observation spectrometer - 12 Å Res. FOV = 2° Altitude = 184 km Zenith measurement Radiation due to Herzberg bands of O_2
Winter & Chubb	1216 Å	$(1.1 - 10) \times 10^{-3}$ ery/cm^2-sec-ster	$(1.1 - 10) \times 10^{-6}$	
Chubbs & Hicks 1970	1050 - 1350 Å	1.2 kR	5.3×10^{-9}	OGO IV - NO photoionization Chambers Zenith Measurements FOV = 65° 40'
Barth & Schaffner	1216 Å 1304 Å 1356 Å	2.5 kR 1.7 kR 1.4 kR	1.64×10^{-7} 1.04×10^{-7} 5.22×10^{-8}	OGO IV - Spectrometer Equatorial Nightglow Resolution = 20 A Zenith Measurements
Prinz & Meirer 1970	1304 Å 1350 - 1600	4-6 kR 25 R	$(3.25-4.88) \times 10^{-7}$ 1.1×10^{-10}	OGO IV - NO photoionization Chambers Zenith Measurements

Table 3

OBSERVATIONS OF THE ULTRAVIOLET AURORA

Reference	Wavelength Region	Quoted Measurement	Earth Radiance w/cm^2 - Ster - u	Comments
Isler & Fastie 1965	[illegible] - [illegible]	Av. = 2.35 kR	9.95×10^{-7}	Rocket Observation and Spectrometer Resolution = 2 Å Sensitivity = .5 kR
Murcray	2000 - 1450 Å [illegible] - 1350 Å	$.08 \times 10^{-3}$ erg/cm^2-sec-ster $.2 \times 10^{-[illegible]}$	$5 \times 10^{-[illegible]}$ $[illegible] \times 10^{-[illegible]}$	Rocket observation NO Photoionization Chamber FOV = 140°
Miller, Fastie & Isler 1968	1180 - 1530 Å 1200 Å (NI) 1300 Å (OI) LBH	1.19 kR 14.4 kR 3.50 kR	$1.06 \times 10^{-[illegible]}$ $1.17 \times 10^{-[illegible]}$ $2.75 \times 10^{-[illegible]}$	Rocket observation Spectrometer Altitude 90-160 km
Chubbs & Hicks 1970	Day 1050 - 1350 Å 1350 - 1550 Å Night 1050 - 1350 Å 1350 - 1550 Å	 1.4 kR .57 kR 2.6 kR 1.0 kR	 1.14×10^{-7} 4.17×10^{-8} 2.11×10^{-7} 7.3×10^{-8}	OGO IV - NO Photoionization Chambers Zenith Measurements
Barth & Schaffner 1970	1304 Å 1356 Å 1384 Å (Nx)	16.2 kR 3 kR 1.4 kR	9.89×10^{-7} 1.76×10^{-7} 8.05×10^{-8}	OGO IV - Spectrometer Zenith Measurements Resolution = 20A

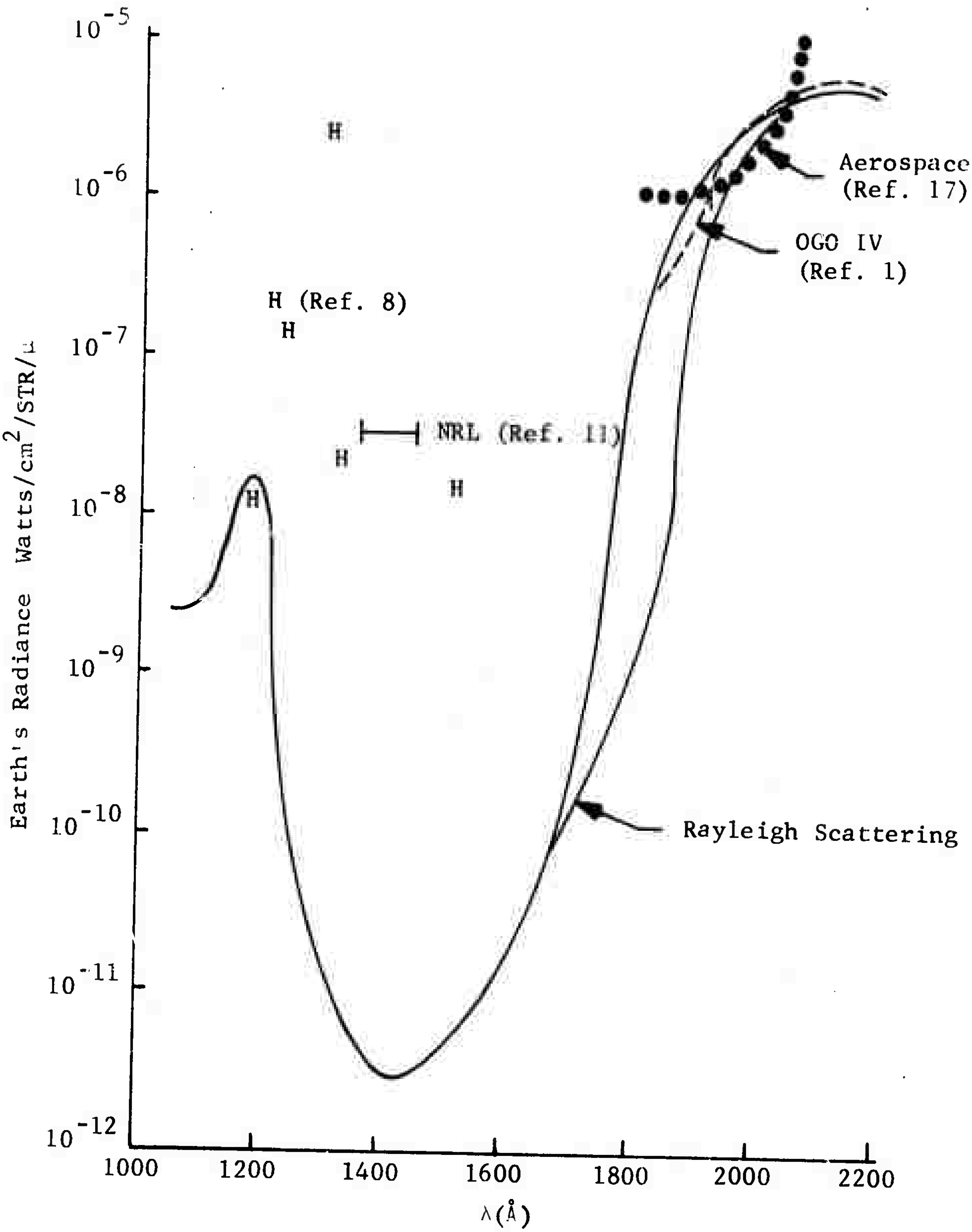

Fig. 1 Various Experimental Measurements of the Earth's Radiance and the Theoretical Values Based on Rayleigh Scattering

chosen for the absorption cross section of molecular oxygen. In addition, it is necessary that a molecular oxygen altitude profile be used in the calculation. For the calculation presented in Fig. 1, we used the ultraviolet flux from the sun as determined by Hinteregger (Ref. 12), the absorption coefficients from Ditchburn (Ref. 13), and the standard atmosphere for the molecular oxygen distribution. The selection of other values for the solar flux and the absorption coefficients or the choice of a different molecular oxygen distribution will tend to shift the curve slightly higher or slightly lower but not by a considerable amount.

The nightglow below 3000Å consists mainly of the Herzberg band of molecular oxygen that occurs primarily between 2500 and 3500Å (Refs. 14,15). The 2972Å line of atomic oxygen is also present. Below 2000Å, the only major radiation is that due to the Lyman alpha line (Refs. 2,7) and the 1304Å triplet of atomic oxygen (Refs. 3,5).

In a search of the literature for previous measurements of the earth's dayglow and nightglow, we have been unable to find any detailed spatial measurements of the earth's limb in the ultraviolet region below 3000Å. Some mention has been made of an apparent brightening effect, but no quantitative measurements were reported. Quantitative measurements are presented in this report.

THE ORBITING ASTRONOMICAL OBSERVATORY A-2

The NASA-Goddard/Grumman Orbiting Astronomical Observatory A-2 was launched 7 December 1968, its mission to make detailed ultraviolet measurements of stars, galaxies, and other heavenly bodies. A set of six-gimbal star trackers and a system of gyros enable the OAO to be pointed with an accuracy of 1 minute of arc and to hold a pointing ±15 arc seconds once it has been stabilized. The A-2 is equipped with the Smithsonian Astrophysical Observatory (SAO) package and the Wisconsin Experiment Package (WEP). The SAO package is designed to make large field sky maps in the ultraviolet, and the WEP obtains precise photometric measurements of individual celestial objects.

The Wisconsin Experiment Package consists of seven instruments designed to make ultraviolet measurements of selected celestial objects. The package includes four 8-inch telescopes incorporating photoelectric photometers, two scanning objective grating spectrometers, and a 16-inch photometer that unfortunately failed after two months of operation.

Each 8-inch telescope has a five-position filter wheel that contains three different interference filters, dark slide, and calibration source. Each is an off-axis paraboloid with a focal length of 81 cm and an effective collecting area of 325 cm^2. The two field stops available at the focal plane have angle diameters of 2 and 10 arc minutes. Stellar photometers 1 and 2 operate at above 1700Å, while stellar photometers 3 and 4 cover the spectral region between 1200 and 2700Å. The response curves for the given filter combinations utilized in the ultraviolet measurements reported in this investigation are shown in Fig. 2. Photometer 1, which contains the 2980Å filter, employ EMI 6256B photomultipliers. Photometer 3, which contains the 2460 and 1920Å filters, utilizes an EMR 541F photomultiplier, while Photometer 4, which has the 1250, 1380, and 1500Å filters, employs an EMR 541G photomultiplier.

The photomultiplier signal is processed by a pulse counter and a d.c. amplifier, providing a digital and analog output, both of which are stored after each exposure. Exposure times of 1/8, 1, 8, or 64-second duration are available by command.

Several modes of operation are available to the experimenter, the choice depending on the type of investigation being conducted. The mode used for most of the airglow measurements was one in which the data sampling was controlled by the scanning spectrometers.

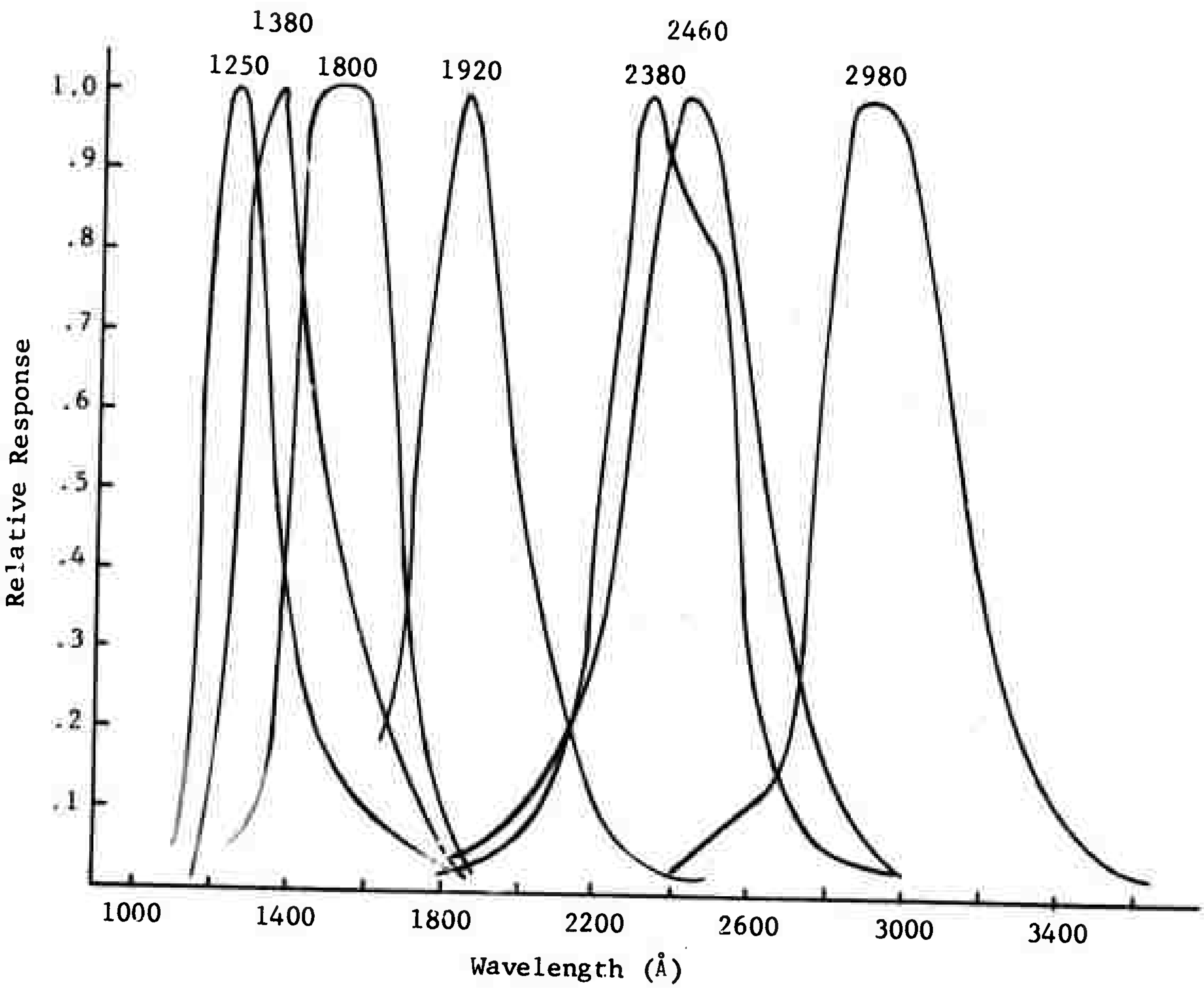

Fig. 2 Relative Response of WEP Filters

Table 4

CALIBRATION FACTORS

EQUIVALENT RADIANCE

(ω/cm^2-ster-μ-count)

Filter	1/8 Sec Exposure	1/2 Sec Exposure	1 Sec Exposure	8 Sec Exposure	64 Sec Exposure
1250Å	1.25×10^{-7}	3.14×10^{-8}	1.57×10^{-8}	1.96×10^{-9}	2.5×10^{-10}
1380Å	6.04×10^{-8}	1.5×10^{-8}	7.55×10^{-9}	9.40×10^{-10}	1.2×10^{-10}
1500Å	2.89×10^{-8}	7.24×10^{-9}	3.63×10^{-9}	4.5×10^{-10}	5.82×10^{-11}
1920Å	7.73×10^{-10}	1.94×10^{-10}	9.71×10^{-11}	1.22×10^{-11}	1.56×10^{-12}
2380Å	4.03×10^{-10}	1.02×10^{-10}	5.07×10^{-11}	6.32×10^{-12}	7.94×10^{-13}
2460Å	2.96×10^{-10}	7.42×10^{-11}	3.70×10^{-11}	4.63×10^{-12}	5.79×10^{-13}
2980Å	7.4×10^{-11}	1.87×10^{-11}	9.46×10^{-12}	1.16×10^{-12}	1.45×10^{-13}

DEGRADATION FACTOR FOR PHOTOMETER 4

($I_{actual} = k\ I_{measured}$)

Filter \ Time	D 161-165 1970	D 268 1970	D 83 1971	D 148 1971	D 215 1971	D 225 1971
1250Å	1.58	2.51	8.32	9.12	10.0	10.0
1380Å	1.15	1.45	4.37	5.25	5.75	5.75
1500Å	1.10	1.20	1.58	1.74	2.09	2.09

One spectrometer was commanded to perform two consecutive 94-step scans. An 8-second exposure period exists between the completion of one step and the initiation of the next step. After the exposure, the data from all instruments are sampled. The actual time to perform a step is approximately 1 second. The exposure times of the photometers can be selected to be 1/8, 1, or 8 seconds and are initiated at the beginning of an 8-second spectrometer exposure.

Another mode of operation was employed for the detailed measurements of the earth's limb. In this mode, the exposure time for all instruments was set at 64 seconds. However, each instrument was sampled at 0.524 second intervals. A total of about $2\frac{1}{2}$ minutes of data can be stored in the spacecraft's data processing system using this mode. When the OAO is in real time contact with a ground station, this mode can provide up to 10 minutes of continuous data.

To obtain measurements of the earth's nightglow, we found it necessary to employ the 64-second exposure mode. This particular mode is the most sensitive, since the signals are integrated over the entire 64-second period. It cannot be used during daylight hours since the photometers would saturate.

The calibration factors for the various filters and modes of operation are given in Table 4. These factors were obtained from calibration tests made prior to launch. Other tests have been conducted in space to validate the factors.

To appreciate the data and the manner in which they were obtained, it is necessary that the reader fully understand the relation between the OAO line of sight (LOS) and the relative position of the earth. All observations were made by inertially fixing the OAO LOS in terms of right ascension and declination. This means that the OAO points at a particular spot on the celestial sphere. The OAO is inertially stabilized such that it will continue pointing at that spot until commanded to another position. Thus, we cannot command the OAO to look at a particular point on the surface of the earth and to follow that point since this was not the original intent of the OAO. Once the OAO is pointed at a particular spot on the celestial sphere, we can obtain measurements of the earth's dayglow, nightglow, and limb by exposing during the time the desired portion of the earth moves through the field of view of the OAO. The position of the OAO relative to the earth during a typical measurement sequence is depicted in Fig. 3. The three positions of the OAO shown in the illustration correspond

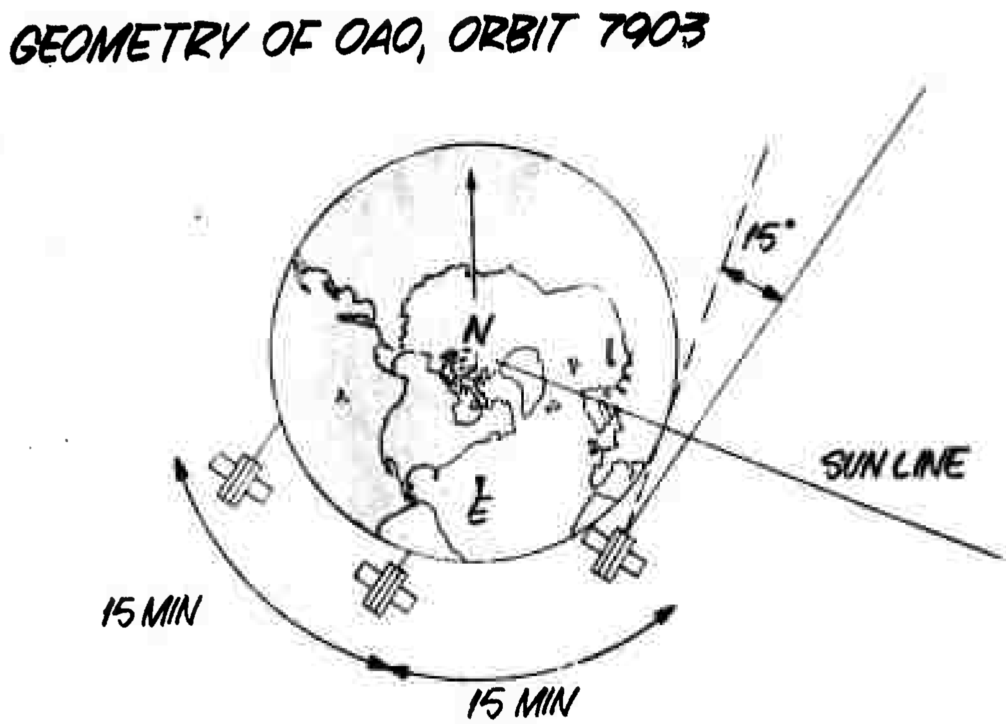

Fig. 3 Relative Position of Earth and OAO during Typical Measurement Sequence

to the position at the beginning, middle, and end of a half-hour measurement sequence. Note in the illustration that the measurements were initially made of the dark earth, then the sunlit portion of the earth, and finally the sunlit limb. Also note that the total amount of sunlit atmosphere in the field of view increases as the earth moves through the field of view. Figure 4 indicates the ground track of the OAO field of view during the measurements period. The viewing situation is typical of those made during the first set of observations and characterizes the manner in which all measurements were made.

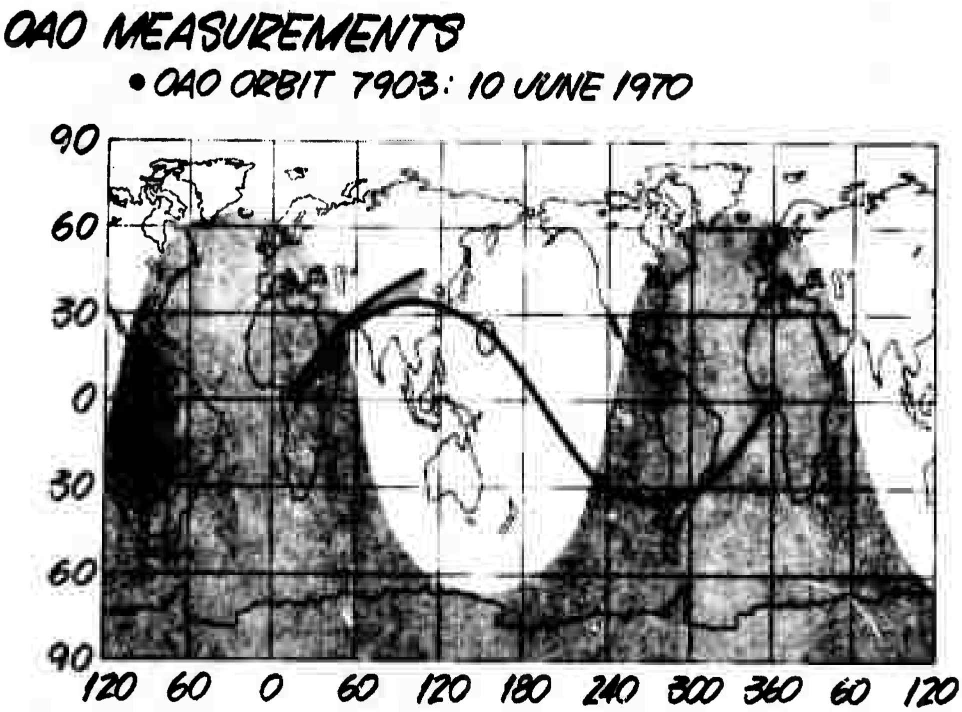

Fig. 4 Ground Track of OAO Field of View during Measurement Sequence Depicted in Fig. 3

DATA REDUCTION

Wisconsin Experiment Package measurements of the earth airglow were made at several different times during 1970-1971. The bulk of the measurements were made over a four-day period (June 10 through June 13, 1970) on 27 different orbits. This set of observations was obtained by programming the OAO to view a star, Alpha-Leo, and to expose during the time this star was occulted by the earth. Each measurement period was approximately 30 minutes long and consisted of a series of 188 exposures of either 1/8, 1, or 8 seconds duration. The experiment was operated in the mode in which the scanning spectrometer controlled the sampling period. Figure 4 indicates the ground track of orbit 7903 during the measurement period.

The variation of the received radiation as the viewing area scans across the earth is indicated in Figs. 5-7. The received radiation is given in terms of the original digital counts or voltage as transmitted from the OAO. Figures 5 and 6 represent data obtained during orbit 7903. Figure 5 indicates the radiation received by the 1250Å photometer and Fig. 6 represents that received by the 1920Å photometer. An interesting feature is apparent on examining these two curves: radiation in the 1250Å regions appears to reach a maximum value after the field of view has left the surface of the earth. This maximum occurs at a tangent altitude of about 175 kilometers. On the other hand, the 1920Å photometer indicates that as the field of view moves off the earth's surface, the radiation begins to decrease rapidly. Figure 7 depicts the radiation received by the 1500Å photometer during a later orbit. This radiation also peaks at a tangent altitude of about 175 kilometers.

The presence of the peak in the radiation indicates that the source of radiation in the 1200-1600Å region is different from that in the 1900Å region. The explanation and theoretical models for these two sources of radiation are given later. Also discussed in a later section is the method of reducing the data to some common basis such that comparisons to other experimental results can be made.

A considerable amount of data was obtained on the earth dayglow, nightglow, sunlit limb, and nighttime limb. Samples of the data are presented later in reduced form. At this point, it is important that the reader understand the geometry and the method of converting the raw data into a measure of the earth's radiance.

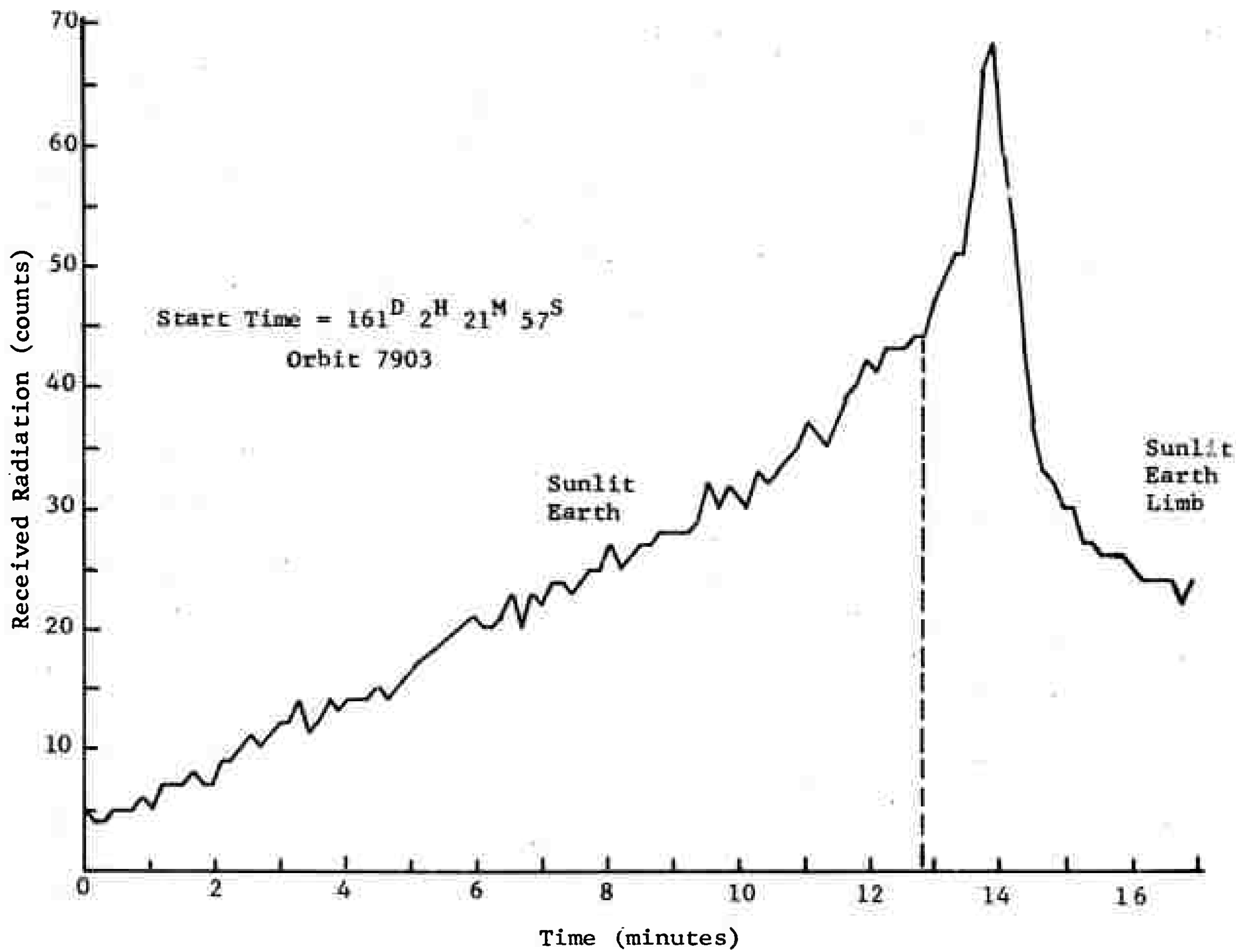

Fig. 5 Received Radiation Measured with 1250Å Filter

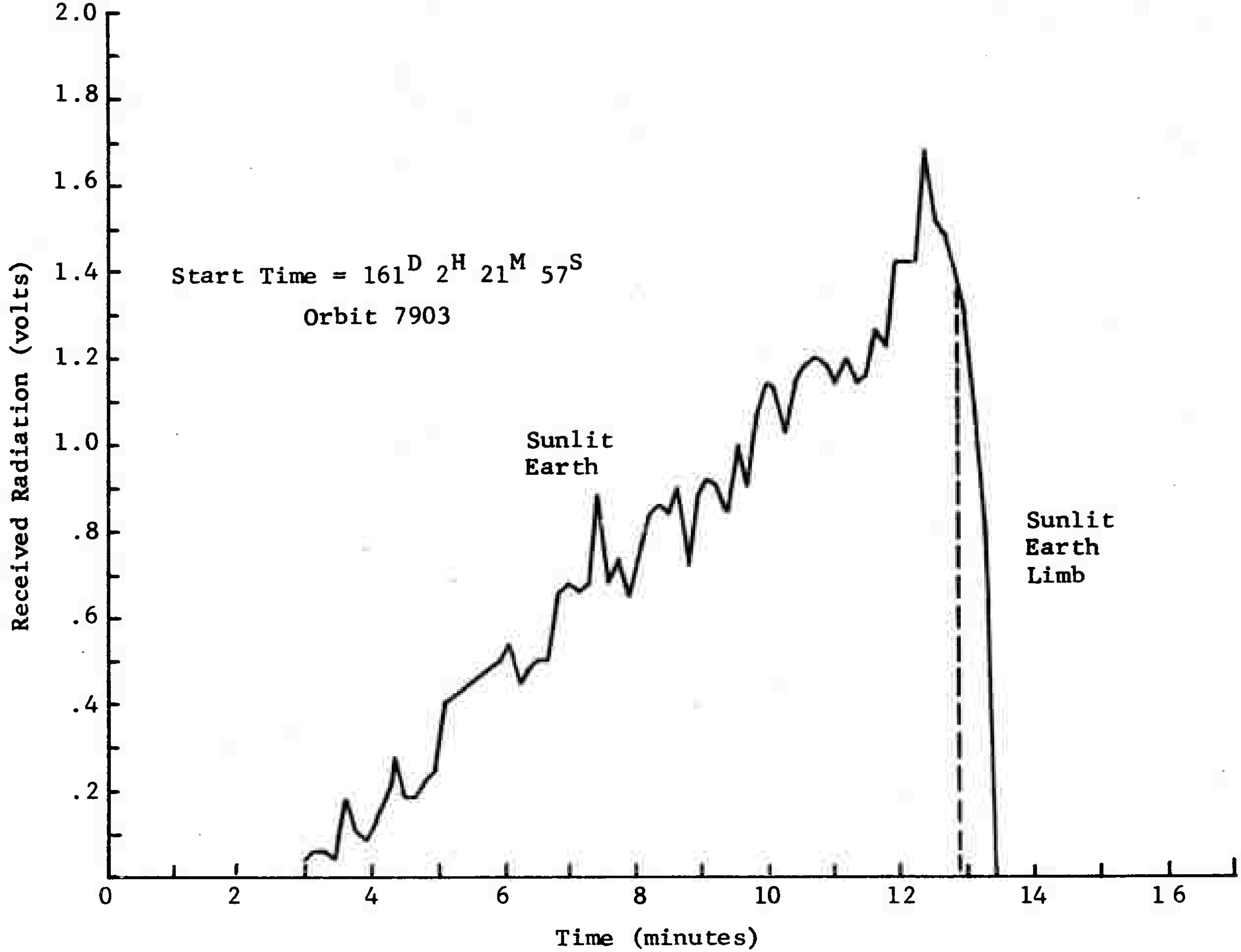

Fig. 6 Received Radiation Measured with 1920Å Filter

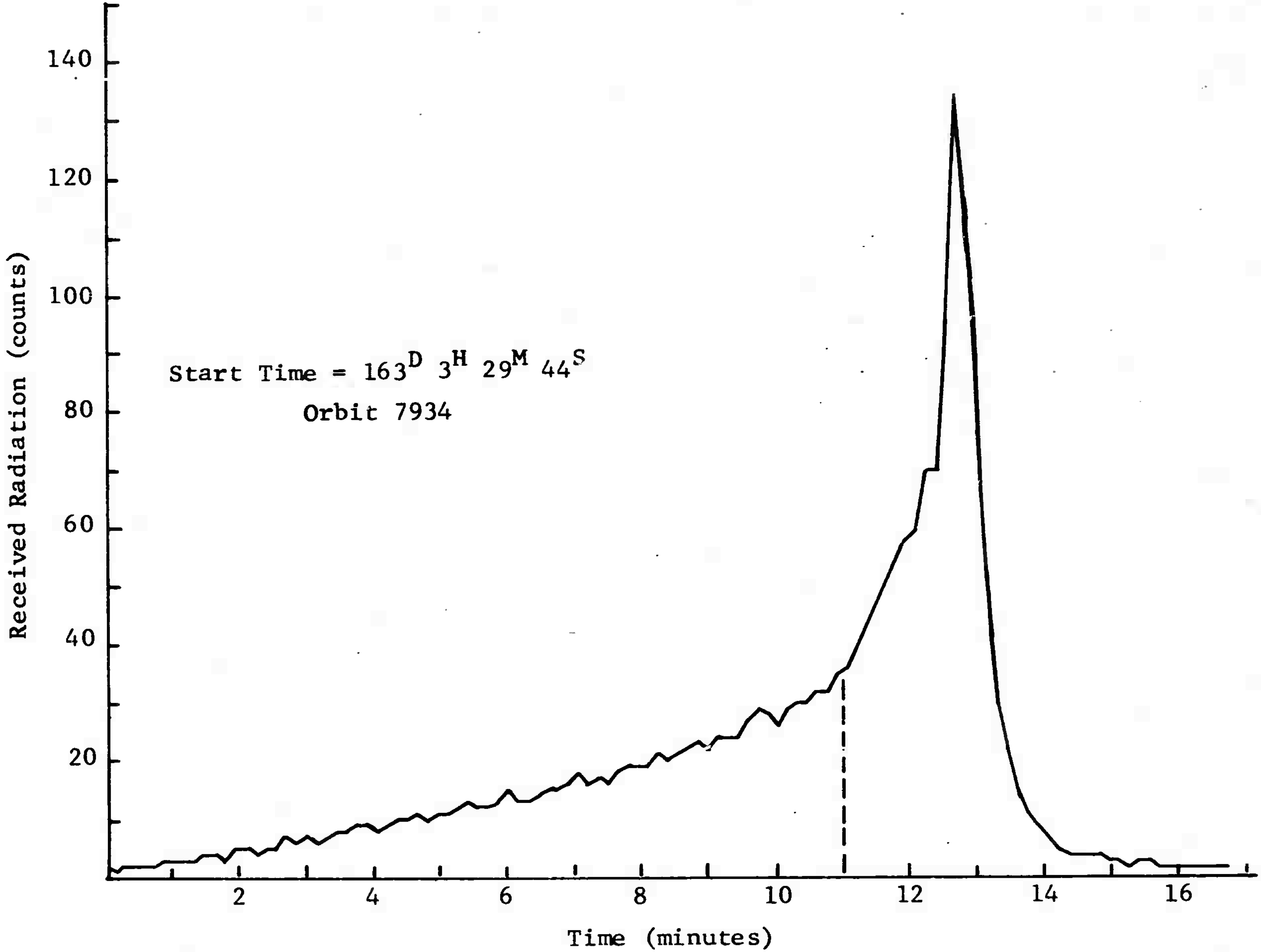

Fig. 7 Received Radiation Measured with 1500Å Filter

Consider a typical viewing situation such as shown in Fig. 8. The total received radiation is the sum of the contributions from each portion of the atmosphere along the line of sight vector, s, that is

$$I_T(s) = \int_{I_r(s=0)}^{I_r(s=\infty)} dI_r(s) \tag{1}$$

where $s = 0$ is the point of intersection with the earth's surface and the upper limit is at $s = \infty$ if the detector is outside the atmosphere. The increment $dI_r(s)$ is the radiation received from emissions originating at a distance, s, from a layer of atmosphere of thickness, ds. Assuming that the source of radiation fills the field of view, we have

$$A_o dI_r(s) = A_e(s)B(s)I(s)T(s)ds \tag{2}$$

A_o = collecting area of the optics (cm^2)

$A_e(s)$ = the area of atmosphere at a distance (s), that contributes to the received radiation (cm^2)

$B(s)$ = the solid angle subtended by the detector at a distance s (steradians)

$T(s)$ = the transmission of the atmosphere from s to the detector

$I(s)$ = atmospheric radiance at s $(w/cm^3\text{-ster})$

Now, by definition

$$A_e(s)B(s) = A_o\alpha \tag{3}$$

where

α = field of view of the detector (steradians)

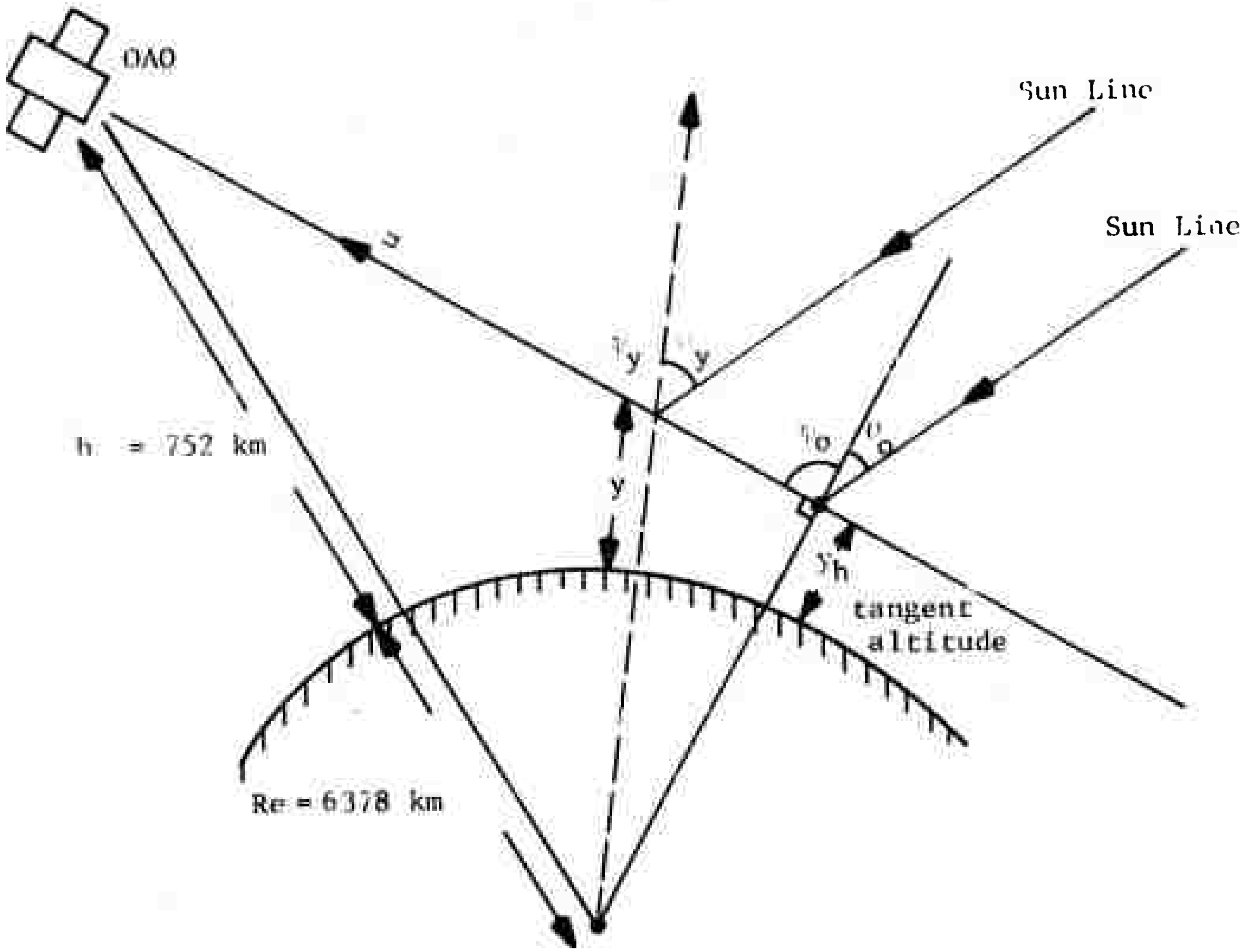

Fig. 8 Typical Viewing Geometry

Hence the radiation received by the detector from a source at a distance s, is

$$dI_r(s) = \alpha I(s) T(s) ds \tag{4}$$

Integrating along the line of sight, the total received radiation is

$$I_T = \alpha \int_{s=0}^{\infty} I(s) T(s) ds \tag{5}$$

$$= \alpha I_B \tag{6}$$

I_B is the equivalent radiance of the earth in w/cm^2-ster. It is dependent on the angle between the LOS and the local zenith and also the position of the sun. The earth's radiance normally is defined by the situation when both the LOS and the sun line lie along the local spacecraft zenith. A method for obtaining this particular value of the radiance from the measured intensities is discussed in the next section, together with some results of this reduction.

The equivalent radiance can be calculated from the measured irradiance values and gives a good indication of the magnitude of the true radiance. Therefore, all measurements have been reduced to their equivalent radiance. The viewing geometry and equivalent radiance for each data sample have been placed on computer cards and tape. Each line of the printout from the cards and tape contains

1) the run number
2) a day or night designation (D or N) to indicate the condition of the area on the earth viewed at the time of the sample
3) the GMT time of the measurement in days, hours, minutes, and seconds
4) the tangent altitude (TAN.ALT) given in kilometers

5) the solar-zenith angle (SUN.ANG), which is the angle between the sun line and the local vertical through the earth at either the intersection point of the LOS with the earth's surface or the tangent altitude point

6) the line-of-sight/zenith angle (OBS ANG), which is the angle between the line of sight and the local vertical at the point indicated in 5)

7) the Rayleigh scattering angle (SCAT ANG), which is the angle between the LOS vector and the sun line

8) the longitude (LON) and latitude (LAT) of either the intersection point of the LOS with the earth's surface or the tangent altitude point

9) the equivalent radiance values from the 1250, 1380, 1920, 2380, 2460, and 2980Å filter photometers of the WEP.

The data samples are given at 3-minute intervals when the dark earth is being observed, at 1-minute intervals for sunlit observations, and every 10 seconds for measurements of the earth limb when the viewing does not intersect the earth's surface. The reduced data for all meaningful observations are given in Table 5. This table represents a computer printout of the data stored on magnetic tape.

TABLE 5

PRINTOUT OF REDUCED OAO DATA

THIS TAPE CONTAINS A SUMMARY OF THE ULTRAVIOLET EARTH BACKGROUND MEASUREMENTS THAT WERE MADE BY THE GRUMMAN AEROSPACE CORPORATION USING THE WISCONSIN EXPERIMENT PACKAGE OF OAO A-2. INFORMATION ON THE VIEWING GEOMETRY AND THE MEASURED RADIANCE VALUES FOR THE PHOTOMETERS ARE GIVEN FOR EACH DATA SAMPLE. THE MEASUREMENTS WERE OBTAINED DURING THE GMT DAYS 161-164 AND 268 OF 1970 AND FOR DAYS 83.146.215 AND 225 OF 1971.

EACH LINE OF PRINTOUT CONTAINS

(1) THE RUN NUMBER

(2) A DAY OR NIGHT DESIGNATION.(D OR N) TO INDICATE THE CONDITION OF THE AREA ON THE EARTH VIEWED AT THE TIME OF THE RUN.

(3) THE GMT TIME OF THE MEASUREMENT IN DAYS.HOURS.MINUTES AND SECONDS.

(4) THE TANGENT ALTITUDE (TAN.ALT) GIVEN IN KILOMETERS WHICH IS THE MINIMUM HEIGHT THAT THE LINE OF SIGHT MAKES WITH THE EARTH'S SURFACE.

(5) THE SOLAR-ZENITH ANGLE (SUN ANG) WHICH IS THE ANGLE BETWEEN THE SUN LINE AND THE LOCAL VERTICAL THROUGH THE EARTH AT EITHER THE INTERSECTION POINT OF THE LOS WITH THE EARTH'S SURFACE OR THE THE TANGENT ALTITUDE POINT.

(6) THE LINE OF SIGHT-ZENITH ANGLE (OBS ANG) WHICH IS THE ANGLE BETWEEN THE LINE OF SIGHT AND THE LOCAL VERTICAL AT THAT POINT.

(7) THE RAYLEIGH SCATTERING ANGLE (SCAT ANG) WHICH IS THE ANGLE BETWEEN THE LINE OF SIGHT VECTOR AND THE SUN LINE.

(8) THE LONGITUDE (LON) AND LATITUDE (LAT) OF THE OAO POSITION.

(9) THE LONGITUDE (LON) AND LATITUDE (LAT) OF EITHER THE INTERSECTION POINT OF THE LOS WITH THE EARTH'S SURFACE OR THE TANGENT ALTITUDE POINT.

(10) THE MEASURED RADIANCE VALUES FROM THE 1250A.1380A.1500A.1920A.2380A. 2460A AND 2980A FILTER PHOTOMETERS OF THE WISCONSIN EXPERIMENT PACKAGE.THESE VALUES WERE OBTAINED BY DIVIDING THE MEASURED IRRADIANCE BY THE FIELD OF VIEW OF THE WEP PHOTOMETERS (6.646X10TO THE -6 STERADIONS). THEY ARE THEREFORE EQUIVALENT RADIANCE VALUES.

RUN NO. I4	D N A2	DAY I4	GMT H I2	GMT M I2	GMT S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAD LON I4	OAD LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
1	D	161	1	12	57	0	134.3	36.0	77.7	25	-1	21	1	4.99E-08	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	15	57	0	127.1	30.8	87.7	34	6	31	8	4.99E-08	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	18	57	0	110.1	29.5	99.3	42	12	40	15	4.99E-08	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	21	57	0	97.9	33.5	112.7	51	17	50	21	1.09E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	22	57	0	93.9	35.5	116.3	54	19	54	23	1.55E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	23	57	0	89.8	37.9	121.1	57	21	57	25	2.14E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	24	57	0	85.7	40.6	125.0	60	23	61	28	2.85E-07	0.0	0.0	1.16E-07	0.0	0.0	0.0
1	D	161	1	25	57	0	81.5	43.5	128.7	63	24	65	30	3.57E-07	0.0	0.0	2.33E-07	0.0	0.0	0.0
1	D	161	1	26	57	0	77.3	46.7	131.9	66	26	69	31	3.92E-07	0.0	0.0	1.16E-06	0.0	0.0	0.0
1	D	161	1	27	57	0	73.0	50.1	134.6	70	27	74	33	5.23E-07	0.0	0.0	1.40E-06	0.0	0.0	0.0
1	D	161	1	28	57	0	68.7	53.7	136.5	73	29	78	35	5.71E-07	0.0	0.0	1.69E-06	0.0	0.0	0.0
1	D	161	1	29	57	0	64.2	57.5	137.4	77	30	83	37	6.18E-07	0.0	0.0	1.86E-06	0.0	0.0	0.0
1	D	161	1	30	57	0	59.5	61.7	137.3	81	31	89	39	6.89E-07	0.0	0.0	2.56E-06	0.0	0.0	0.0
1	D	161	1	31	53	0	55.0	65.9	135.3	84	32	94	40	7.85E-07	0.0	0.0	3.20E-06	0.0	0.0	0.0
1	D	161	1	32	53	0	49.6	71.1	132.9	88	33	101	42	8.80E-07	0.0	0.0	3.49E-06	0.0	0.0	0.0
1	D	161	1	33	53	0	43.3	77.7	127.7	92	33	110	44	9.98E-07	0.0	0.0	4.13E-06	0.0	0.0	0.0
1	D	161	1	34	53	36	33.5	90.0	116.0	96	34	127	47	1.14E-06	0.0	0.0	3.93E-06	0.0	0.0	0.0
1	D	161	1	35	3	64	33.3	90.0	115.7	97	34	127	46	1.21E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	35	13	92	33.0	90.0	115.4	97	34	127	46	1.25E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	35	23	120	32.8	90.0	115.1	98	34	127	46	1.26E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	35	33	146	32.5	90.0	114.3	99	34	127	45	1.64E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	35	43	173	32.3	90.0	114.5	99	34	127	45	1.68E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	35	53	199	32.0	90.0	114.2	100	35	127	45	1.43E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	36	3	224	31.8	90.0	113.9	101	35	127	45	1.26E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	36	13	249	31.5	90.0	113.7	101	35	127	44	1.07E-06	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	36	23	274	31.3	90.0	113.4	102	35	127	44	9.27E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	36	33	297	31.1	90.0	113.1	103	35	127	44	8.08E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	36	43	321	30.8	90.0	112.8	104	35	126	43	7.85E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	36	53	343	30.6	90.0	112.5	104	35	128	43	7.61E-07	0.0	0.0	0.0	0.0	0.0	0.0
1	D	161	1	37	53	469	29.3	90.0	110.9	108	35	128	41	6.18E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	2	51	46	0	140.1	39.7	74.3	356	-3	352	-2	4.99E-08	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	2	54	46	0	127.9	33.0	82.9	5	3	1	5	4.99E-08	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	2	57	46	0	115.8	30.0	94.1	13	9	11	12	6.89E-08	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	0	46	0	103.7	31.5	106.3	21	15	20	18	9.27E-08	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	1	46	0	99.6	33.0	111.1	24	17	24	21	1.05E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	2	46	0	95.6	34.9	115.4	27	19	27	23	1.24E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	3	46	0	91.5	37.1	119.5	30	20	31	25	1.90E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	4	46	0	87.4	39.7	123.6	33	22	34	27	2.62E-07	0.0	0.0	5.82E-08	0.0	0.0	0.0
2	D	161	3	5	46	0	83.3	42.5	127.3	37	24	38	29	3.33E-07	0.0	0.0	1.75E-07	0.0	0.0	0.0
2	D	161	3	6	59	0	78.2	46.2	131.4	41	26	43	31	4.40E-07	0.0	0.0	7.57E-07	0.0	0.0	0.0
2	D	161	3	7	59	0	73.9	49.5	134.2	44	27	48	33	4.99E-07	0.0	0.0	1.22E-06	0.0	0.0	0.0
2	D	161	3	8	59	0	69.6	53.1	136.2	48	28	52	35	5.47E-07	0.0	0.0	1.98E-06	0.0	0.0	0.0
2	D	161	3	9	59	0	65.1	56.9	137.4	51	30	57	37	5.94E-07	0.0	0.0	2.15E-06	0.0	0.0	0.0
2	D	161	3	10	59	0	60.5	61.0	137.4	55	31	62	38	6.66E-07	0.0	0.0	2.62E-06	0.0	0.0	0.0
2	D	161	3	11	59	0	55.6	65.4	136.2	59	32	68	40	7.85E-07	0.0	0.0	3.00E-06	0.0	0.0	0.0
2	D	161	3	12	59	0	50.3	70.5	132.4	62	33	75	42	8.56E-07	0.0	0.0	3.38E-06	0.0	0.0	0.0
2	D	161	3	13	59	0	44.2	76.9	128.5	66	33	83	43	9.98E-07	0.0	0.0	3.78E-06	0.0	0.0	0.0
2	D	161	3	14	59	16	33.8	90.0	116.3	70	34	101	47	1.12E-06	0.0	0.0	3.96E-06	0.0	0.0	0.0
2	D	161	3	15	9	45	33.5	90.0	116.0	71	34	101	47	1.18E-06	0.0	0.0	3.93E-06	0.0	0.0	0.0
2	D	161	3	15	19	73	33.3	90.0	115.7	72	34	102	46	1.26E-06	0.0	0.0	3.17E-06	0.0	0.0	0.0

RUN ID NO. I4	N A2	DAY I4	GMT H I3	M I3	S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAO LON I4	OAO LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2462A 1PE9.2	2900A 1PE9.2
2	D	161	3	15	29	101	33.0	90.0	115.4	72	34	102	46	1.37E-06	0.0	0.0	1.02E-06	0.0	0.0	0.0
2	D	161	3	15	39	128	32.8	90.0	115.1	73	34	102	46	1.45E-06	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	15	49	155	32.5	90.0	114.8	74	34	102	45	1.59E-06	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	15	59	181	32.3	90.0	114.5	74	35	102	45	1.71E-06	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	16	9	207	32.0	90.0	114.2	75	35	102	45	1.59E-06	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	16	19	232	31.8	90.0	113.9	76	35	102	45	1.30E-06	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	16	29	257	31.5	90.0	113.6	77	35	102	44	1.15E-06	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	16	39	281	31.3	90.0	113.3	77	35	102	44	5.75E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	16	49	304	31.1	90.0	113.0	78	35	102	44	8.80E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	16	59	327	30.8	90.0	112.7	79	35	102	43	7.85E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	17	59	454	29.5	90.0	111.1	83	35	103	42	6.18E-07	0.0	0.0	0.0	0.0	0.0	0.0
2	D	161	3	18	59	561	28.3	90.0	109.5	87	35	103	40	5.71E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	40	4	0	127.5	30.8	103.0	353	13	352	17	7.37E-08	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	43	4	0	95.3	35.2	115.8	2	19	2	23	1.29E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	44	4	0	91.2	37.5	120.0	5	21	6	25	1.78E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	45	4	0	87.1	40.0	124.0	8	22	9	27	2.73E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	46	4	0	83.0	42.9	127.7	12	24	13	29	3.33E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	47	4	0	78.8	45.9	131.1	15	26	17	31	3.80E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	48	4	0	74.6	49.2	133.9	18	27	22	33	4.28E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	49	1	0	70.4	52.5	136.0	22	28	26	35	5.47E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	50	1	0	66.0	56.2	137.3	25	30	31	36	5.94E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	51	1	0	61.4	60.3	137.6	29	31	36	38	6.42E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	52	1	0	56.6	64.6	136.5	33	32	42	40	7.37E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	53	1	0	51.4	69.0	134.1	37	33	49	41	8.32E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	54	1	0	45.5	75.6	129.6	41	33	57	43	9.27E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	55	1	0	36.7	86.0	120.3	45	34	71	46	1.07E-06	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	56	1	152	32.6	90.0	114.8	49	34	77	45	1.59E-06	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	56	11	173	32.4	90.0	114.5	49	35	77	45	1.69E-06	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	56	21	204	32.1	90.0	114.2	50	35	77	45	1.40E-06	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	56	31	229	31.9	90.0	113.9	51	35	77	45	1.14E-06	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	56	41	254	31.6	90.0	113.6	51	35	77	44	9.98E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	56	51	273	31.4	90.0	113.4	52	35	77	44	9.03E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	57	1	302	31.2	90.0	113.1	53	35	77	44	8.08E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	58	1	432	29.8	90.0	111.4	57	35	78	42	6.18E-07	0.0	0.0	0.0	0.0	0.0	0.0
3	D	161	4	59	1	542	28.5	90.0	109.7	61	35	78	40	5.71E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	18	54	0	113.1	30.4	97.3	324	11	322	14	6.66E-08	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	21	54	0	101.0	32.9	110.0	333	17	332	20	9.27E-08	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	22	54	0	97.0	34.6	114.3	336	18	336	23	1.07E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	23	54	0	92.9	36.7	118.5	339	20	339	25	2.00E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	24	54	0	88.8	39.2	122.6	342	22	343	27	2.85E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	25	54	0	84.7	41.9	126.4	345	24	347	29	3.33E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	26	54	0	80.5	44.8	129.9	348	25	351	31	3.80E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	27	50	0	76.6	47.8	132.8	352	26	355	32	4.75E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	28	50	0	72.3	51.2	135.3	355	28	359	34	5.47E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	29	50	0	67.9	54.8	136.9	359	29	4	36	6.18E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	30	50	0	63.4	58.7	137.6	2	30	9	38	6.66E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	31	50	0	58.6	62.9	137.1	6	31	14	39	7.61E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	32	50	0	53.6	67.6	135.3	10	32	21	41	8.56E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	33	50	0	48.1	73.0	131.7	14	33	28	42	9.51E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	34	50	0	41.1	80.5	125.4	18	34	38	45	1.05E-06	0.0	0.0	0.0	0.0	0.0	0.0

RUN NO. I4	D N A2	DAY I4	GMT H I3	M I3	S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	DAD LON I4	DAD LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
4	D	161	6	35	50	87	33.3	90.0	115.6	22	34	51	45	1.28E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	36	0	115	33.0	90.0	115.3	22	34	51	45	1.43E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	36	10	142	32.8	90.0	115.0	23	34	52	46	1.55E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	36	20	168	32.5	90.0	114.7	24	35	52	45	1.74E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	36	30	194	32.3	90.0	114.4	25	35	52	45	1.62E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	36	40	219	32.0	90.0	114.1	25	35	52	45	1.43E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	[illegible]	[illegible]	244	31.8	90.0	113.8	26	35	52	44	1.28E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	37	0	268	31.5	90.0	113.5	27	35	52	44	1.14E-06	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	37	10	292	31.3	90.0	113.2	27	35	52	44	9.98E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	37	20	315	31.1	90.0	112.9	28	35	52	44	9.03E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	37	30	338	30.8	90.0	112.6	29	35	52	43	8.08E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	37	40	360	30.6	90.0	112.3	29	35	52	43	7.61E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	37	50	382	30.4	90.0	112.1	30	35	52	43	7.13E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	38	50	[illegible]	29.1	90.0	110.4	34	35	53	41	6.42E-07	0.0	0.0	0.0	0.0	0.0	0.0
4	D	161	6	39	50	598	27.9	90.0	108.9	38	35	53	39	5.94E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	7	54	5	0	133.5	36.3	79.4	285	1	281	2	3.80E-08	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	7	57	5	0	121.4	31.6	95.5	293	7	291	9	5.47E-08	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	0	5	0	109.3	31.0	101.5	302	13	300	16	7.13E-08	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	3	5	0	97.2	34.8	114.3	310	18	310	23	1.12E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	4	5	0	93.1	36.8	118.5	313	20	314	25	1.85E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	5	5	0	89.0	39.2	122.5	317	22	317	27	2.38E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	6	5	0	84.9	41.9	126.4	320	24	321	29	3.33E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	7	5	0	80.7	44.8	129.9	323	25	325	31	3.80E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	8	5	0	76.5	48.0	132.9	327	27	330	33	4.28E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	9	2	0	72.4	51.2	135.3	330	28	334	34	5.23E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	10	2	0	68.0	54.8	137.0	333	29	339	36	5.94E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	11	2	0	63.5	58.7	137.7	337	30	344	38	6.66E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	12	2	0	58.8	62.9	137.2	341	32	349	39	7.85E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	13	2	0	53.8	67.5	135.3	345	32	355	41	8.56E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	14	2	0	48.2	73.0	131.8	349	33	3	42	9.27E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	15	2	0	41.3	80.4	125.5	353	34	13	45	1.09E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	16	2	85	33.4	90.0	115.6	357	34	26	46	1.31E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	16	12	112	33.1	90.0	115.3	357	34	26	46	1.40E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	16	22	139	32.9	90.0	115.0	358	35	26	46	1.57E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	16	32	165	32.6	90.0	114.7	359	35	26	45	1.76E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	16	42	191	32.4	90.0	114.4	359	35	27	45	1.59E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	16	52	217	32.1	90.0	114.1	360	35	27	45	1.37E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	17	2	242	31.9	90.0	113.8	1	35	27	44	1.21E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	17	12	265	31.6	90.0	113.5	1	35	27	44	1.07E-06	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	17	22	290	31.4	90.0	113.2	2	35	27	44	9.39E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	17	32	313	31.2	90.0	113.0	3	35	27	44	8.80E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	17	42	336	30.9	90.0	112.7	3	35	27	43	8.08E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	17	52	358	30.7	90.0	112.4	4	35	27	43	7.61E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	18	2	380	30.5	90.0	112.1	5	35	27	43	7.13E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	19	2	498	29.2	90.0	110.4	9	35	28	41	6.42E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	20	2	596	27.9	90.0	108.8	13	35	28	39	5.94E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	21	2	673	26.8	90.0	107.2	17	35	28	36	5.71E-07	0.0	0.0	0.0	0.0	0.0	0.0
5	D	161	8	22	2	728	25.7	90.0	105.6	21	34	29	36	5.59E-07	0.0	0.0	0.0	0.0	0.0	0.0
6	D	161	18	2	56	0	103.5	33.7	108.9	155	17	154	21	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
6	D	161	18	3	56	0	99.4	35.1	113.1	158	19	157	23	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0

RUN NO. I4	D N A2	DAY I4	GMT H I3	M I3	S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAO LON I4	OAO LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1720A 1PE9.2	2330A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
6	D	161	18	4	56	0	95.4	36.9	117.2	161	22	161	25	0.0	2.94E-08	0.0	0.0	0.0	0.0	0.0
6	D	161	18	5	56	0	91.3	39.0	121.3	164	22	164	27	0.0	6.58E-08	0.0	0.0	0.0	0.0	0.0
6	D	161	18	6	56	0	87.2	41.5	125.2	167	24	168	29	0.0	1.12E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	7	56	0	83.0	44.2	129.8	170	25	172	31	0.0	1.49E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	8	56	0	78.8	47.2	132.0	174	27	176	33	0.0	1.90E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	9	56	0	74.6	50.4	134.7	177	28	181	34	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	10	56	0	70.2	53.8	136.7	181	29	185	36	0.0	2.60E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	11	56	0	65.7	57.5	137.7	185	31	190	33	0.0	3.11E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	12	56	0	61.1	61.5	137.7	188	32	196	39	0.0	3.81E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	13	56	0	56.2	65.9	136.4	192	33	202	41	0.0	4.15E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	14	56	0	50.9	70.9	133.5	196	33	209	42	0.0	4.85E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	15	56	0	44.8	77.2	128.6	200	34	217	44	0.0	5.71E-07	0.0	0.0	0.0	0.0	0.0
6	D	161	18	16	56	20	34.5	90.0	116.6	204	34	235	47	0.0	6.75E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	43	1	0	104.1	33.7	108.4	129	17	128	20	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
7	D	161	19	44	1	0	100.1	35.1	112.6	132	18	131	23	0.0	1.73E-08	0.0	0.0	0.0	0.0	0.0
7	D	161	19	45	1	0	96.0	36.8	116.3	135	20	135	25	0.0	1.73E-08	0.0	0.0	0.0	0.0	0.0
7	D	161	19	46	1	0	91.9	38.9	120.9	138	22	139	27	0.0	5.36E-08	0.0	0.0	0.0	0.0	0.0
7	D	161	19	47	1	0	87.8	41.3	124.8	141	24	142	29	0.0	9.69E-08	0.0	0.0	0.0	0.0	0.0
7	D	161	19	48	1	0	83.7	44.0	128.4	145	25	146	31	0.0	1.42E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	49	1	0	79.5	46.9	131.7	148	27	151	33	0.0	1.73E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	50	1	0	75.2	50.0	134.4	152	28	155	34	0.0	2.08E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	51	1	0	70.9	53.4	136.5	155	29	160	36	0.0	2.60E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	52	1	0	66.4	57.1	137.7	159	30	165	38	0.0	3.11E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	53	1	0	61.8	61.0	137.8	163	32	170	39	0.0	3.46E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	54	1	0	57.0	65.3	136.7	166	32	176	41	0.0	4.15E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	55	1	0	51.7	70.2	134.0	170	33	183	42	0.0	4.67E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	56	1	0	45.7	76.3	129.4	174	34	191	44	0.0	5.19E-07	0.0	0.0	0.0	0.0	0.0
7	D	161	19	57	1	0	35.8	88.3	118.4	178	34	207	47	0.0	6.23E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	23	9	0	104.5	33.9	108.2	104	17	102	20	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
8	D	161	21	24	9	0	100.5	35.1	112.4	107	18	106	23	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
8	D	161	21	25	9	0	96.4	36.8	116.6	110	20	109	25	0.0	1.73E-08	0.0	0.0	0.0	0.0	0.0
8	D	161	21	26	9	0	92.3	38.9	120.6	113	22	113	27	0.0	4.33E-08	0.0	0.0	0.0	0.0	0.0
8	D	161	21	27	9	0	88.2	41.2	124.5	116	24	117	29	0.0	9.17E-08	0.0	0.0	0.0	0.0	0.0
8	D	161	21	28	9	0	84.1	43.9	128.2	119	25	121	31	0.0	1.32E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	29	9	0	79.9	46.7	131.5	123	27	125	33	0.0	1.68E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	30	9	0	75.6	49.9	134.3	126	28	129	34	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	31	9	0	71.3	53.2	136.4	130	29	134	36	0.0	2.60E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	32	9	0	66.9	56.8	137.7	133	30	139	38	0.0	2.94E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	33	9	0	62.3	60.7	137.9	137	32	144	39	0.0	3.46E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	34	9	0	57.5	65.0	136.8	141	32	150	41	0.0	3.98E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	35	9	0	52.3	69.8	134.3	145	33	157	42	0.0	4.33E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	36	9	0	46.3	75.7	129.9	149	34	165	44	0.0	5.02E-07	0.0	0.0	0.0	0.0	0.0
8	D	161	21	37	9	0	37.6	85.8	120.8	153	34	179	46	0.0	6.23E-07	0.0	0.0	0.0	0.0	0.0
9	D	161	23	3	57	0	102.5	34.5	110.3	80	18	79	22	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
9	D	161	23	4	57	0	98.4	36.0	114.5	83	19	82	24	0.0	1.73E-08	0.0	0.0	0.0	0.0	0.0
9	D	161	23	5	57	0	94.4	37.8	118.6	86	21	86	26	0.0	3.46E-08	0.0	0.0	0.0	0.0	0.0
9	D	161	23	6	57	0	90.3	40.0	122.6	89	23	90	28	0.0	7.44E-08	0.0	0.0	0.0	0.0	0.0
9	D	161	23	7	57	0	86.2	42.5	126.4	92	24	94	30	0.0	1.21E-07	0.0	0.0	0.0	0.0	0.0
9	D	161	23	8	57	0	82.0	45.3	129.9	96	26	98	32	0.0	1.56E-07	0.0	0.0	0.0	0.0	0.0
9	D	161	23	9	57	0	77.8	48.3	132.9	99	27	102	33	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0

RUN NO. I4	D N A2	GMT DAY I4	H I3	M I3	S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAO LON I4	OAO LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
90		161	23	10	57	0	73.5	51.6	135.4	103	29	107	35	0.0	2.60E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	11	57	0	63.1	55.0	137.1	106	30	111	37	0.0	2.94E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	12	57	0	64.5	58.8	137.3	110	31	117	38	0.0	3.46E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	13	57	0	59.9	62.9	137.5	114	32	122	40	0.0	3.98E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	14	57	0	54.9	67.4	135.7	118	33	128	41	0.0	4.33E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	15	57	0	49.4	72.7	132.3	122	34	136	43	0.0	5.02E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	16	57	0	42.7	79.7	126.4	126	34	145	45	0.0	5.88E-07	0.0	0.0	0.0	0.0	0.0
90		161	23	17	57	59	34.1	90.0	116.0	130	35	160	47	0.0	6.92E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	43	3	0	107.1	33.5	105.8	51	16	50	19	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
100		162	0	44	3	0	103.0	34.5	109.9	54	17	53	22	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
100		162	0	45	3	0	99.0	36.0	114.1	57	19	57	24	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
100		162	0	46	3	0	94.9	37.8	118.2	60	21	60	26	0.0	2.60E-08	0.0	0.0	0.0	0.0	0.0
100		162	0	47	3	0	90.8	39.9	122.2	64	23	64	28	0.0	6.58E-08	0.0	0.0	0.0	0.0	0.0
100		162	0	48	3	0	86.7	42.4	126.0	67	24	68	30	0.0	1.02E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	49	3	0	82.5	45.1	129.6	70	26	72	32	0.0	1.56E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	50	3	0	78.3	48.1	132.7	74	27	76	33	0.0	1.90E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	51	3	0	74.0	51.3	135.2	77	29	81	35	0.0	2.42E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	52	3	0	69.7	54.7	137.0	81	30	86	37	0.0	2.77E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	53	3	0	65.2	58.4	137.9	85	31	91	38	0.0	3.29E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	54	3	0	60.5	62.4	137.6	88	32	96	40	0.0	3.81E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	55	3	0	55.6	66.9	136.0	92	33	102	41	0.0	4.33E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	56	3	0	50.2	72.0	132.3	96	34	110	43	0.0	4.67E-07	0.0	0.0	0.0	0.0	0.0
100		162	0	57	3	0	43.7	78.7	127.3	100	34	119	45	0.0	5.36E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	23	57	0	104.4	34.4	108.8	28	17	27	21	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
110		162	2	24	57	0	100.3	35.7	112.9	31	19	30	23	0.0	1.38E-08	0.0	0.0	0.0	0.0	0.0
110		162	2	25	57	0	96.3	37.3	117.0	34	21	34	25	0.0	2.77E-08	0.0	0.0	0.0	0.0	0.0
110		162	2	26	57	0	92.2	39.4	121.1	37	22	38	27	0.0	6.40E-08	0.0	0.0	0.0	0.0	0.0
110		162	2	27	57	0	88.1	41.7	124.9	41	24	42	29	0.0	1.00E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	28	57	0	83.9	44.3	128.6	44	26	46	31	0.0	1.44E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	29	57	0	79.7	47.2	131.8	47	27	50	33	0.0	1.90E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	30	57	0	75.5	50.3	134.5	51	28	54	35	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	31	57	0	71.1	53.7	136.6	54	30	59	36	0.0	2.60E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	32	57	0	66.7	57.3	137.7	58	31	64	38	0.0	2.94E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	33	57	0	62.1	61.2	137.8	62	32	69	39	0.0	3.63E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	34	57	0	57.2	65.5	136.7	66	33	75	41	0.0	4.15E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	35	57	0	52.0	70.3	134.0	70	33	82	42	0.0	4.67E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	36	57	0	46.0	76.4	129.5	74	34	90	44	0.0	5.19E-07	0.0	0.0	0.0	0.0	0.0
110		162	2	37	57	0	36.0	88.4	118.4	78	35	107	47	0.0	6.40E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	4	53	0	101.6	35.4	111.0	5	19	4	23	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
120		162	4	5	53	0	97.5	37.0	116.0	8	20	8	25	0.0	2.25E-08	0.0	0.0	0.0	0.0	0.0
120		162	4	6	53	0	93.4	38.9	120.0	11	22	11	27	0.0	6.96E-08	0.0	0.0	0.0	0.0	0.0
120		162	4	7	53	0	89.3	41.2	124.0	14	24	15	29	0.0	9.00E-08	0.0	0.0	0.0	0.0	0.0
120		162	4	8	53	0	85.2	43.7	127.6	18	25	19	31	0.0	1.33E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	9	53	0	81.0	46.5	131.0	21	27	23	33	0.0	1.73E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	10	53	0	76.8	49.5	133.9	25	28	28	34	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	11	53	0	72.4	52.8	136.1	28	29	32	36	0.0	2.77E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	12	53	0	68.0	56.3	137.5	32	31	37	38	0.0	2.94E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	13	53	0	63.5	60.1	137.9	36	32	43	39	0.0	3.63E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	14	53	0	58.7	64.3	137.2	40	33	48	41	0.0	3.98E-07	0.0	0.0	0.0	0.0	0.0
120		162	4	15	53	0	53.6	68.9	135.0	43	33	55	42	0.0	4.85E-07	0.0	0.0	0.0	0.0	0.0

RUN NO. I4	D N A2	GMT DAY I4	H I3	M I3	S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAO LON I4	OAO LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
12	D	162	4	16	53	0	47.9	74.5	121.0	47	34	63	44	0.0	5.19E-07	0.0	0.0	0.0	0.0	0.0
12	D	162	4	17	53	0	42.7	82.2	123.7	51	34	74	46	0.0	6.40E-07	0.0	0.0	0.0	0.0	0.0
12	D	162	4	18	53	115	37.9	90.0	115.5	56	35	85	46	0.0	7.96E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	44	55	0	102.4	35.4	111.2	339	18	338	23	0.0	1.35E-08	0.0	0.0	0.0	0.0	0.0
13	D	162	5	45	55	0	98.3	36.5	115.4	342	20	342	25	0.0	1.35E-08	0.0	0.0	0.0	0.0	0.0
13	D	162	5	46	55	0	94.2	38.7	119.4	345	22	345	27	0.0	4.33E-08	0.0	0.0	0.0	0.0	0.0
13	D	162	5	47	55	0	90.1	40.9	123.3	349	24	349	29	0.0	5.65E-08	0.0	0.0	0.0	0.0	0.0
13	D	162	5	48	55	0	86.0	43.7	127.1	352	25	353	31	0.0	1.30E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	49	55	0	81.8	46.1	130.5	355	27	357	32	0.0	1.73E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	50	55	0	77.6	49.0	133.4	359	28	2	34	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	51	55	0	73.3	52.3	135.8	2	29	6	36	0.0	2.69E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	52	55	0	68.9	55.7	137.4	6	30	11	37	0.0	3.11E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	53	55	0	64.4	59.4	138.0	10	31	16	39	0.0	3.46E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	54	55	0	59.7	63.5	137.4	14	32	22	40	0.0	3.98E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	55	55	0	54.6	68.1	135.5	18	33	28	42	0.0	4.50E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	56	55	0	49.1	73.4	131.0	22	34	36	43	0.0	5.19E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	57	55	0	42.1	80.8	125.6	26	34	46	45	0.0	6.23E-07	0.0	0.0	0.0	0.0	0.0
13	D	162	5	58	55	86	34.2	90.0	115.9	30	35	59	47	0.0	7.79E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	24	48	0	103.8	35.2	110.0	313	18	312	22	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
14	D	162	7	25	48	0	99.7	36.5	114.1	316	20	315	24	0.0	1.73E-08	0.0	0.0	0.0	0.0	0.0
14	D	162	7	26	48	0	95.7	38.2	118.2	319	21	319	26	0.0	2.94E-08	0.0	0.0	0.0	0.0	0.0
14	D	162	7	27	48	0	91.6	40.3	122.2	322	23	323	28	0.0	6.06E-08	0.0	0.0	0.0	0.0	0.0
14	D	162	7	28	48	0	87.5	42.6	125.9	326	25	327	30	0.0	1.12E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	29	48	0	83.3	45.2	129.5	329	26	331	32	0.0	1.47E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	30	48	0	79.1	48.1	132.6	332	28	335	34	0.0	1.90E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	31	48	0	74.8	51.2	135.1	336	29	340	35	0.0	2.25E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	32	48	0	70.5	54.6	137.0	340	30	344	37	0.0	2.77E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	33	48	0	66.0	58.2	137.9	343	31	349	39	0.0	3.29E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	34	48	0	61.3	62.2	137.8	347	32	355	40	0.0	3.81E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	35	48	0	56.4	66.5	136.3	351	33	1	41	0.0	4.15E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	36	48	0	51.1	71.5	133.3	355	34	8	43	0.0	4.35E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	37	48	0	44.8	77.9	128.2	359	34	17	45	0.0	5.71E-07	0.0	0.0	0.0	0.0	0.0
14	D	162	7	38	48	32	34.9	90.0	116.6	3	35	34	48	0.0	6.92E-07	0.0	0.0	0.0	0.0	0.0
15	D	162	8	59	0	0	128.1	36.7	87.5	271	6	267	9	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	2	0	0	116.0	34.1	98.1	279	12	277	16	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	5	0	0	103.9	35.4	110.1	288	18	287	22	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	6	0	0	99.9	36.7	114.2	291	20	290	24	0.0	1.21E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	7	0	0	95.8	38.4	118.2	294	22	294	26	0.0	2.08E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	8	0	0	91.7	40.4	122.2	297	23	297	28	0.0	6.06E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	9	0	0	87.6	42.7	126.0	300	25	301	30	0.0	9.52E-08	0.0	0.0	0.0	0.0	0.0
15	D	162	9	10	0	0	83.4	45.3	129.5	304	26	305	32	0.0	1.45E-07	0.0	0.0	0.0	0.0	0.0
15	D	162	9	11	0	0	79.2	48.2	132.6	307	28	310	34	0.0	2.08E-07	0.0	0.0	0.0	0.0	0.0
15	D	162	9	12	0	0	75.0	51.3	135.2	311	29	314	36	0.0	2.42E-07	0.0	0.0	0.0	0.0	0.0
15	D	162	9	13	0	0	70.6	54.6	137.0	314	30	319	37	0.0	2.60E-07	0.0	0.0	0.0	0.0	0.0
16	D	162	18	59	0	0	133.7	40.4	85.1	116	5	111	7	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
16	D	162	19	2	0	0	121.6	36.2	94.4	124	11	121	14	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
16	D	162	19	5	0	0	109.5	35.6	105.7	132	17	131	20	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
16	D	162	19	8	0	0	97.4	38.9	117.7	142	22	141	27	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
16	D	162	19	9	0	0	93.3	40.7	121.6	145	24	145	29	0.0	0.0	7.94E-09	0.0	0.0	0.0	0.0
16	D	162	19	10	0	0	89.2	42.8	125.4	148	25	149	31	0.0	0.0	1.21E-08	5.82E-08	0.0	0.0	0.0

RUN NO. 14	O N A2	DAY I4	GMT H I3	M I3	S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAD LON I4	OAD LAT I4	OBS LON I4	OBS LAT I4	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
16	D	162	19	11	0	0	35.1	45.3	126.9	152	27	153	32	0.0	0.0	2.15E-08	0.0	0.0	0.0	0.0
16	D	162	19	12	0	0	80.9	43.0	132.1	155	28	157	34	0.0	0.0	3.14E-08	5.82E-07	0.0	0.0	0.0
16	D	162	19	13	0	0	76.6	50.3	134.7	159	29	162	36	0.0	0.0	3.64E-08	1.05E-06	0.0	0.0	0.0
17	D	162	20	35	57	0	147.0	43.6	78.3	82	-2	75	0	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
17	D	162	20	38	57	0	134.8	41.2	84.7	90	4	85	7	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
17	D	162	20	41	57	0	122.7	36.7	93.7	98	10	95	13	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
17	D	162	20	44	57	0	110.6	35.8	104.3	106	16	104	20	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
17	D	162	20	47	57	0	98.5	38.6	116.7	116	22	115	26	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
17	D	162	20	48	57	0	94.5	40.3	120.7	119	23	119	28	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
17	D	162	20	49	57	0	90.4	42.4	124.5	122	25	123	30	0.0	0.0	1.09E-08	0.0	0.0	0.0	0.0
17	D	162	20	50	57	0	86.2	44.7	128.1	125	26	127	32	0.0	0.0	1.82E-08	5.82E-08	0.0	0.0	0.0
17	D	162	20	51	57	0	82.1	47.3	131.3	129	28	131	34	0.0	0.0	2.48E-08	5.82E-07	0.0	0.0	0.0
17	D	162	20	52	57	0	77.8	50.2	134.1	132	29	135	35	0.0	0.0	3.64E-08	1.19E-06	0.0	0.0	0.0
18	D	162	22	17	42	0	140.7	44.7	81.6	60	1	55	4	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
18	D	162	22	20	42	0	128.6	38.7	89.2	69	8	65	10	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
18	D	162	22	23	42	0	116.6	36.0	99.4	77	14	74	17	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
18	D	162	22	26	42	0	104.5	37.0	111.0	86	19	84	23	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
18	D	162	22	27	42	0	100.5	38.1	115.0	89	21	88	26	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
18	D	162	22	28	42	0	96.4	39.7	118.9	92	23	92	28	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
18	D	162	22	29	42	0	92.3	41.6	122.8	95	24	95	29	0.0	0.0	7.94E-09	0.0	0.0	0.0	0.0
18	D	162	22	30	42	0	88.2	43.7	126.5	99	26	99	31	0.0	0.0	1.21E-08	0.0	0.0	0.0	0.0
18	D	162	22	31	42	0	84.1	46.2	129.9	102	27	104	33	0.0	0.0	2.65E-08	2.62E-07	0.0	0.0	0.0
19	D	163	0	4	54	0	112.7	36.1	103.2	55	16	52	19	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
19	D	163	0	7	54	0	100.6	38.3	115.0	64	21	63	26	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
19	D	163	0	8	54	0	96.5	39.8	119.0	67	23	66	28	0.0	0.0	6.62E-09	0.0	0.0	0.0	0.0
19	D	163	0	9	54	0	92.5	41.7	122.8	70	24	70	30	0.0	0.0	7.78E-09	0.0	0.0	0.0	0.0
19	D	163	0	10	54	0	88.3	43.8	126.5	73	26	74	31	0.0	0.0	1.26E-08	0.0	0.0	0.0	0.0
19	D	163	0	11	54	0	84.2	46.3	129.9	77	27	78	33	0.0	0.0	2.65E-08	1.75E-07	0.0	0.0	0.0
19	D	163	0	12	54	0	80.0	49.0	133.0	80	29	83	35	0.0	0.0	3.14E-08	5.82E-07	0.0	0.0	0.0
20	D	163	1	48	49	0	97.8	39.5	117.9	41	22	40	27	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
20	D	163	1	49	49	0	93.7	41.2	121.3	44	24	44	29	0.0	0.0	8.28E-09	0.0	0.0	0.0	0.0
20	D	163	1	50	49	0	89.6	43.3	125.5	47	26	48	31	0.0	0.0	1.21E-08	0.0	0.0	0.0	0.0
20	D	163	1	51	49	0	85.5	45.6	129.0	51	27	52	33	0.0	0.0	2.48E-08	2.91E-07	0.0	0.0	0.0
20	D	163	1	52	49	0	81.3	48.3	132.2	54	28	56	35	0.0	0.0	3.31E-08	6.40E-07	0.0	0.0	0.0
20	D	163	1	53	49	0	77.1	51.1	134.8	58	30	61	36	0.0	0.0	3.97E-08	9.89E-07	0.0	0.0	0.0
20	D	163	1	54	49	0	72.8	54.3	136.8	61	31	66	38	0.0	0.0	4.80E-08	1.34E-06	0.0	0.0	0.0
20	D	163	1	55	49	0	68.3	57.6	138.0	65	32	71	39	0.0	0.0	5.96E-08	2.04E-06	0.0	0.0	0.0
20	D	163	1	56	49	0	63.7	61.3	138.1	69	33	76	41	0.0	0.0	7.28E-08	2.76E-06	0.0	0.0	0.0
20	D	163	1	57	49	0	58.9	65.4	137.1	73	33	82	42	0.0	0.0	7.94E-08	3.17E-06	0.0	0.0	0.0
20	D	163	1	58	49	0	53.8	70.0	134.6	77	34	89	43	0.0	0.0	9.93E-08	3.78E-06	0.0	0.0	0.0
20	D	163	1	59	49	0	47.9	75.6	130.4	81	34	97	44	0.0	0.0	1.16E-07	3.78E-06	0.0	0.0	0.0
21	D	163	3	26	44	0	107.2	37.1	105.0	8	18	6	23	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
21	D	163	3	27	44	0	103.1	38.0	112.9	11	20	10	25	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
21	D	163	3	28	44	0	99.1	39.2	116.9	14	22	14	27	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
21	D	163	3	29	44	0	95.0	40.8	120.7	18	24	17	29	0.0	0.0	5.79E-09	0.0	0.0	0.0	0.0
21	D	163	3	30	44	0	90.9	42.8	124.5	21	25	21	31	0.0	0.0	1.18E-08	0.0	0.0	0.0	0.0
21	D	163	3	31	44	0	86.8	45.0	128.1	24	27	25	32	0.0	0.0	1.82E-08	2.91E-07	0.0	0.0	0.0
21	D	163	3	32	44	0	82.6	47.6	131.3	28	28	30	34	0.0	0.0	2.48E-08	5.24E-07	0.0	0.0	0.0
21	D	163	3	33	44	0	78.4	50.3	134.1	31	29	34	36	0.0	0.0	3.31E-08	1.02E-06	0.0	0.0	0.0
21	D	163	3	34	44	0	74.1	53.4	136.3	35	31	39	37	0.0	0.0	4.47E-08	1.31E-06	0.0	0.0	0.0

RUN NO. 14	D N A2	DAY 14	GMT H 13	M 13	S 13	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	DAD LON 14	DAD LAT 14	OBS LON 14	OBS LAT 14	1250A 1PE9	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
210	163	3	35	44	0	69.7	56.7	137.7	39	32	44	39	0.0	0.0	5.13E-08	1.75E-06	0.0	0.0	0.0
210	163	3	36	44	0	65.2	60.2	138.2	43	32	49	40	0.0	0.0	6.29E-08	2.18E-06	0.0	0.0	0.0
210	163	3	37	44	0	60.5	64.2	137.5	47	33	55	42	0.0	0.0	7.78E-08	2.47E-06	0.0	0.0	0.0
210	163	3	38	44	0	55.4	68.6	135.5	51	34	62	43	0.0	0.0	9.10E-08	2.85E-06	0.0	0.0	0.0
210	163	3	39	44	0	49.9	73.8	131.9	55	34	65	44	0.0	0.0	1.09E-07	3.26E-06	0.0	0.0	0.0
210	163	3	40	44	0	42.9	81.0	125.6	59	35	79	46	0.0	0.0	1.41E-07	3.49E-06	0.0	0.0	0.0
210	163	3	41	41	75	35.1	90.0	116.2	63	35	93	47	0.0	0.0	2.40E-07	0.0	0.0	0.0	0.0
210	163	3	41	51	101	34.8	90.0	115.8	63	35	93	47	0.0	0.0	2.48E-07	0.0	0.0	0.0	0.0
210	163	3	42	1	127	34.5	90.0	115.5	64	35	93	46	0.0	0.0	2.81E-07	0.0	0.0	0.0	0.0
210	163	3	42	11	152	34.2	90.0	115.1	65	35	93	46	0.0	0.0	3.97E-07	0.0	0.0	0.0	0.0
210	163	3	42	21	176	33.9	90.0	114.8	65	35	93	46	0.0	0.0	5.30E-07	0.0	0.0	0.0	0.0
210	163	3	42	31	200	33.6	90.0	114.4	66	35	93	45	0.0	0.0	4.63E-07	0.0	0.0	0.0	0.0
210	163	3	42	41	224	33.3	90.0	114.1	67	35	93	45	0.0	0.0	3.14E-07	0.0	0.0	0.0	0.0
210	163	3	42	51	247	33.1	90.0	113.7	67	35	93	45	0.0	0.0	2.07E-07	0.0	0.0	0.0	0.0
210	163	3	43	1	270	32.8	90.0	113.4	68	35	94	44	0.0	0.0	1.11E-07	0.0	0.0	0.0	0.0
210	163	3	43	11	292	32.5	90.0	113.1	69	35	94	44	0.0	0.0	7.28E-08	0.0	0.0	0.0	0.0
210	163	3	43	21	314	32.3	90.0	112.7	69	35	94	44	0.0	0.0	4.97E-08	0.0	0.0	0.0	0.0
210	163	3	43	31	336	32.0	90.0	112.4	70	35	94	43	0.0	0.0	3.81E-08	0.0	0.0	0.0	0.0
210	163	3	43	41	357	31.7	90.0	112.1	71	35	94	43	0.0	0.0	2.81E-08	0.0	0.0	0.0	0.0
220	163	5	6	50	0	107.7	37.2	108.7	343	18	341	23	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
220	163	5	7	50	0	103.7	38.0	112.6	346	20	344	25	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
220	163	5	8	50	0	99.6	39.2	116.5	349	22	348	27	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
220	163	5	9	50	0	95.6	40.8	120.4	352	24	352	29	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
220	163	5	10	50	0	91.5	42.7	124.2	355	25	356	31	0.0	0.0	9.77E-09	0.0	0.0	0.0	0.0
220	163	5	11	50	0	87.3	44.9	127.7	359	27	360	32	0.0	0.0	2.15E-08	1.45E-07	0.0	0.0	0.0
220	163	5	12	50	0	83.2	47.4	131.0	2	28	4	34	0.0	0.0	2.48E-08	4.07E-07	0.0	0.0	0.0
220	163	5	13	50	0	79.0	50.1	133.9	6	29	8	36	0.0	0.0	3.64E-08	6.73E-07	0.0	0.0	0.0
220	163	5	14	50	0	74.7	53.1	136.1	9	30	13	37	0.0	0.0	4.47E-08	1.28E-06	0.0	0.0	0.0
220	163	5	15	50	0	70.3	56.3	137.7	13	32	18	39	0.0	0.0	5.30E-08	1.86E-06	0.0	0.0	0.0
220	163	5	16	50	0	65.8	59.9	138.2	17	32	24	40	0.0	0.0	6.29E-08	2.24E-06	0.0	0.0	0.0
220	163	5	17	50	0	61.1	63.7	137.7	21	33	29	41	0.0	0.0	7.61E-08	2.76E-06	0.0	0.0	0.0
220	163	5	18	50	0	56.1	68.1	135.9	25	34	36	43	0.0	0.0	9.27E-08	2.97E-06	0.0	0.0	0.0
220	163	5	19	50	0	50.6	73.1	132.4	29	34	43	44	0.0	0.0	1.09E-07	3.08E-06	0.0	0.0	0.0
220	163	5	20	50	0	43.9	79.9	126.6	33	35	53	45	0.0	0.0	1.37E-07	3.43E-06	0.0	0.0	0.0
230	163	6	48	54	0	100.3	39.2	116.0	323	22	322	27	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
230	163	6	49	54	0	96.2	40.7	119.9	326	23	326	29	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
230	163	6	50	54	0	92.1	42.5	123.7	330	25	330	30	0.0	0.0	1.03E-08	0.0	0.0	0.0	0.0
230	163	6	51	54	0	88.0	44.7	127.3	333	27	334	32	0.0	0.0	1.49E-08	0.0	0.0	0.0	0.0
230	163	6	52	54	0	83.9	47.1	130.6	336	28	338	34	0.0	0.0	2.48E-08	2.91E-07	0.0	0.0	0.0
230	163	6	53	54	0	79.7	49.8	133.5	340	29	343	36	0.0	0.0	3.14E-08	7.57E-07	0.0	0.0	0.0
240	163	8	29	6	0	100.4	39.4	116.1	298	22	297	27	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
240	163	8	30	6	0	96.3	40.9	120.0	301	24	301	29	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
240	163	8	31	6	0	92.3	42.7	123.7	304	25	305	31	0.0	0.0	1.11E-08	0.0	0.0	0.0	0.0
240	163	8	32	6	0	88.2	44.8	127.3	308	27	309	32	0.0	0.0	1.59E-08	0.0	0.0	0.0	0.0
240	163	8	33	6	0	84.0	47.2	130.5	311	28	313	34	0.0	0.0	2.15E-08	1.45E-07	0.0	0.0	0.0
240	163	8	34	6	0	79.8	49.8	133.5	315	29	317	36	0.0	0.0	2.65E-08	4.66E-07	0.0	0.0	0.0
250	163	10	8	59	0	101.8	39.2	114.0	272	21	270	26	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
250	163	10	9	59	0	97.7	40.5	118.8	275	23	274	28	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
250	163	10	10	59	0	93.7	42.2	122.6	278	25	278	30	0.0	0.0	3.97E-09	0.0	0.0	0.0	0.0
250	163	10	11	59	0	89.5	44.2	126.2	281	26	282	32	0.0	0.0	1.21E-08	0.0	0.0	0.0	0.0

RUN NO.	D N	GMT DAY	H	M	S	TAN ALT	SUN ANG	OBS ANG	SCAT ANG	SAC LON	SAC LAT	OBS LON	OBS LAT	1250A	1380A	1500A	1920A	2380A	2460A	2900A
I4	A2	I4	I3	I3	I3	I4	F6.1	F6.1	F6.1	I4	I4	I4	I4	1PE9.2	1PE9.2	1PE9.2	1PE9.2	1PE9.2	1PE9.2	1PE9.2
25	D	163	10	12	59	0	35.4	46.5	129.6	285	28	286	34	0.0	0.0	2.07E-08	2.91E-08	0.0	0.0	0.0
25	D	163	10	13	59	0	81.3	49.0	132.7	283	29	291	35	0.0	0.0	2.48E-08	4.66E-07	0.0	0.0	0.0
26	D	164	2	52	57	0	95.0	43.4	122.3	25	26	25	31	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	D	164	2	54	57	0	86.8	47.2	129.6	32	29	33	35	0.0	0.0	0.0	2.33E-07	0.0	0.0	0.0
26	D	164	2	55	57	0	82.6	49.6	132.6	36	30	38	36	0.0	0.0	0.0	6.40E-07	0.0	0.0	0.0
26	D	164	2	56	57	0	78.4	52.2	135.1	40	31	43	38	0.0	0.0	0.0	8.44E-07	0.0	0.0	0.0
26	D	164	2	57	57	0	74.1	55.1	137.0	43	32	47	39	0.0	0.0	0.0	1.28E-06	0.0	0.0	0.0
26	D	164	2	58	57	0	69.7	58.2	138.1	47	33	53	40	0.0	0.0	0.0	1.63E-06	0.0	0.0	0.0
26	D	164	2	59	57	0	65.2	61.7	138.2	51	34	58	42	0.0	0.0	0.0	2.21E-06	0.0	0.0	0.0
26	D	164	3	0	57	0	60.4	65.5	137.2	55	34	64	43	0.0	0.0	0.0	2.39E-06	0.0	0.0	0.0
26	D	164	3	1	57	0	55.3	69.8	134.9	59	35	71	44	0.0	0.0	0.0	2.91E-06	0.0	0.0	0.0
26	D	164	3	2	57	0	49.6	75.0	131.0	63	35	79	45	0.0	0.0	0.0	3.26E-06	0.0	0.0	0.0
27	D	164	4	34	2	0	91.5	45.0	125.9	3	27	3	33	0.0	0.0	3.14E-08	0.0	0.0	0.0	0.0
27	D	164	4	35	2	0	87.4	47.1	129.3	7	28	8	35	0.0	0.0	3.14E-08	0.0	0.0	0.0	0.0
27	D	164	4	36	2	0	83.2	49.4	132.3	10	30	12	36	0.0	0.0	3.14E-08	4.66E-07	0.0	0.0	0.0
27	D	164	4	37	2	0	79.0	51.9	134.8	14	31	17	38	0.0	0.0	4.14E-08	9.31E-07	0.0	0.0	0.0
27	D	164	4	38	2	0	74.7	54.7	136.3	18	32	22	39	0.0	0.0	6.29E-08	1.28E-06	0.0	0.0	0.0
27	D	164	4	39	2	0	70.4	57.8	138.0	22	33	27	40	0.0	0.0	6.29E-08	1.98E-06	0.0	0.0	0.0
27	D	164	4	40	2	0	65.8	61.2	138.3	25	33	32	42	0.0	0.0	7.94E-08	2.39E-06	0.0	0.0	0.0
27	D	164	4	41	2	0	61.1	65.0	137.4	29	34	38	43	0.0	0.0	7.94E-08	2.62E-06	0.0	0.0	0.0
27	D	164	4	42	2	0	56.1	69.2	135.3	34	35	45	44	0.0	0.0	9.60E-08	2.85E-06	0.0	0.0	0.0
27	D	164	4	43	2	0	50.5	74.2	131.6	38	35	53	45	0.0	0.0	1.16E-07	3.29E-06	0.0	0.0	0.0
27	D	164	4	44	2	0	43.5	81.3	125.3	42	35	63	46	0.0	0.0	1.29E-07	3.49E-06	0.0	0.0	0.0
28	N	215	8	30	10	59	126.5	90.0	143.0	199	33	231	36	0.0	0.0	1.51E-08	1.94E-10	3.06E-10	0.0	2.06E-09
28	N	215	8	30	11	62	126.6	90.0	143.0	200	33	231	36	0.0	0.0	0.0	0.0	3.06E-10	0.0	2.15E-09
28	N	215	8	30	12	65	126.6	90.0	143.0	200	33	231	36	0.0	0.0	0.0	0.0	3.06E-10	0.0	4.21E-09
28	N	215	8	30	13	68	126.6	90.0	142.9	200	33	231	36	0.0	0.0	0.0	0.0	4.08E-10	0.0	2.67E-09
28	N	215	8	30	14	70	126.6	90.0	142.9	200	33	231	36	0.0	0.0	1.51E-08	1.94E-10	4.08E-10	0.0	2.94E-09
28	N	215	8	30	15	73	126.7	90.0	142.9	200	33	230	36	0.0	0.0	0.0	0.0	4.08E-10	0.0	3.27E-09
28	N	215	8	30	16	75	126.7	90.0	142.8	200	33	230	36	0.0	0.0	0.0	0.0	5.10E-10	0.0	3.52E-09
28	N	215	8	30	17	79	126.7	90.0	142.8	200	33	230	36	0.0	0.0	0.0	1.94E-10	5.10E-10	0.0	3.80E-09
28	N	215	8	30	18	82	126.8	90.0	142.8	200	33	230	35	0.0	0.0	1.51E-08	1.94E-10	6.12E-10	0.0	4.08E-09
28	N	215	8	30	19	84	126.8	90.0	142.7	200	33	230	35	0.0	0.0	0.0	1.94E-10	7.14E-10	0.0	4.39E-09
28	N	215	8	30	20	87	126.8	90.0	142.7	200	32	230	35	0.0	0.0	0.0	0.0	8.16E-10	0.0	4.86E-09
28	N	215	8	30	21	90	126.9	90.0	142.7	200	32	230	35	0.0	0.0	0.0	1.94E-10	9.18E-10	0.0	5.33E-09
28	N	215	8	30	22	93	126.9	90.0	142.6	200	32	230	35	0.0	0.0	0.0	1.94E-10	9.18E-10	0.0	5.89E-09
28	N	215	8	30	23	96	126.9	90.0	142.6	200	32	230	35	0.0	0.0	0.0	0.0	1.02E-09	0.0	7.11E-09
28	N	215	8	30	24	98	127.0	90.0	142.6	200	32	230	35	0.0	0.0	1.51E-08	1.94E-10	1.12E-09	0.0	8.88E-09
28	N	215	8	30	25	101	127.0	90.0	142.5	200	32	230	35	0.0	0.0	0.0	1.94E-10	1.43E-09	0.0	1.07E-08
28	N	215	8	30	26	104	127.0	90.0	142.5	201	32	230	35	0.0	0.0	0.0	1.94E-10	1.73E-09	0.0	1.01E-08
28	N	215	8	30	27	107	127.1	90.0	142.5	201	32	230	35	0.0	0.0	1.51E-08	3.88E-10	1.63E-09	0.0	7.85E-09
28	N	215	8	30	28	109	127.1	90.0	142.4	201	32	230	35	0.0	0.0	0.0	1.94E-10	1.33E-09	0.0	5.24E-09
28	N	215	8	30	29	112	127.1	90.0	142.4	201	32	230	35	0.0	0.0	1.51E-08	1.94E-10	9.18E-10	0.0	3.37E-09
28	N	215	8	30	30	115	127.2	90.0	142.4	201	32	230	35	0.0	0.0	0.0	0.0	6.12E-10	0.0	1.68E-09
28	N	215	8	30	31	118	127.2	90.0	142.4	201	32	230	35	0.0	0.0	1.51E-08	0.0	3.06E-10	0.0	9.35E-10
28	N	215	8	30	32	120	127.2	90.0	142.3	201	32	230	35	0.0	0.0	0.0	1.94E-10	2.04E-10	0.0	5.61E-10
28	N	215	8	30	33	123	127.2	90.0	142.3	201	32	230	35	0.0	0.0	0.0	1.94E-10	1.02E-10	0.0	4.67E-10
28	N	215	8	30	34	126	127.3	90.0	142.3	201	32	230	35	0.0	0.0	1.51E-08	0.0	1.02E-10	0.0	3.74E-10
28	N	215	8	30	35	129	127.3	90.0	142.2	201	32	230	35	0.0	0.0	0.0	1.94E-10	1.02E-10	0.0	3.37E-10
28	N	215	8	30	36	131	127.3	90.0	142.2	201	32	230	35	0.0	0.0	1.51E-08	1.94E-10	1.02E-10	0.0	3.37E-10

RUN NO. 14	D N A2	DAY 14	GMT H 13	M 13	S 13	TAN ALT 14	SUN ANG F6.1	OBS ANG F5.1	SCAT ANG F6.1	OAO LON 14	OAO LAT 14	OBS LON 14	OBS LAT 14	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
28	N	215	8	30	37	134	127.4	90.0	142.2	201	32	230	35	0.0	0.0	0.0	1.54E-10	1.02E-10	0.0	3.37E-10
28	N	215	8	30	38	137	127.4	90.0	142.1	201	32	230	35	0.0	0.0	0.0	0.0	1.02E-10	0.0	3.37E-10
28	N	215	8	30	39	139	127.4	90.0	142.1	201	32	230	35	0.0	0.0	1.51E-08	0.0	1.02E-10	0.0	3.37E-10
29	D	268	17	11	31	399	34.2	90.0	122.9	293	31	271	32	0.0	0.0	8.69E-09	0.0	0.0	0.0	0.0
29	D	268	17	11	41	375	34.1	90.0	122.8	294	30	271	32	0.0	0.0	1.74E-08	0.0	0.0	0.0	0.0
29	D	268	17	11	51	355	34.1	90.0	122.7	294	30	271	32	0.0	0.0	2.61E-08	0.0	0.0	0.0	0.0
29	D	268	17	12	1	325	34.0	90.0	122.7	295	30	271	32	0.0	0.0	4.34E-08	0.0	0.0	0.0	0.0
29	D	268	17	12	11	299	33.9	90.0	122.6	296	30	271	32	0.0	0.0	6.95E-08	0.0	0.0	0.0	0.0
29	D	268	17	12	21	272	33.8	90.0	122.5	296	30	271	32	0.0	0.0	1.22E-07	0.0	0.0	0.0	0.0
29	D	268	17	12	31	244	33.8	90.0	122.4	297	29	271	32	0.0	0.0	2.52E-07	0.0	0.0	0.0	0.0
29	D	268	17	12	41	216	33.7	90.0	122.4	298	29	271	32	0.0	0.0	4.95E-07	0.0	0.0	0.0	0.0
29	D	268	17	12	51	187	33.6	90.0	122.3	298	29	271	32	0.0	0.0	9.38E-07	0.0	0.0	0.0	0.0
29	D	268	17	13	1	157	33.5	90.0	122.2	299	29	271	32	0.0	0.0	5.82E-07	0.0	0.0	0.0	0.0
29	D	268	17	13	11	127	33.4	90.0	122.1	299	29	271	32	0.0	0.0	4.52E-07	0.0	0.0	0.0	0.0
29	D	268	17	13	21	96	33.4	90.0	122.0	300	28	271	31	0.0	0.0	4.08E-07	0.0	0.0	0.0	0.0
29	D	268	17	13	31	64	33.3	90.0	122.0	301	28	271	31	0.0	0.0	4.08E-07	0.0	0.0	0.0	0.0
29	D	268	17	13	41	31	33.2	90.0	121.9	301	28	271	31	0.0	0.0	4.08E-07	0.0	0.0	0.0	0.0
30	D	268	18	51	41	407	34.2	90.0	122.9	268	31	246	32	0.0	0.0	8.69E-09	0.0	0.0	0.0	0.0
30	D	268	18	51	51	383	34.1	90.0	122.8	269	30	246	32	0.0	0.0	8.69E-09	0.0	0.0	0.0	0.0
30	D	268	18	52	1	359	34.0	90.0	122.7	269	30	246	32	0.0	0.0	1.74E-08	0.0	0.0	0.0	0.0
30	D	268	18	52	11	333	33.9	90.0	122.6	270	30	246	32	0.0	0.0	1.74E-08	0.0	0.0	0.0	0.0
30	D	268	18	52	21	308	33.9	90.0	122.5	270	30	246	32	0.0	0.0	5.21E-08	0.0	0.0	0.0	0.0
30	D	268	18	52	31	281	33.8	90.0	122.4	271	30	246	32	0.0	0.0	6.95E-08	0.0	0.0	0.0	0.0
30	D	258	18	52	41	253	33.7	90.0	122.4	272	29	246	32	0.0	0.0	1.65E-07	0.0	0.0	0.0	0.0
30	D	258	18	52	51	225	33.6	90.0	122.3	272	29	246	32	0.0	0.0	2.55E-07	0.0	0.0	0.0	0.0
30	D	268	18	53	1	197	33.5	90.0	122.2	273	29	246	32	0.0	0.0	6.26E-07	0.0	0.0	0.0	0.0
30	D	268	18	53	11	167	33.5	90.0	122.1	273	29	246	32	0.0	0.0	1.04E-06	0.0	0.0	0.0	0.0
30	D	268	18	53	21	137	33.4	90.0	122.0	274	29	246	31	0.0	0.0	6.69E-07	0.0	0.0	0.0	0.0
30	D	268	18	53	31	106	33.3	90.0	122.0	275	28	246	31	0.0	0.0	4.95E-07	0.0	0.0	0.0	0.0
30	D	268	18	53	41	74	33.2	90.0	121.9	275	28	246	31	0.0	0.0	4.08E-07	0.0	0.0	0.0	0.0
30	D	268	18	53	51	42	33.1	90.0	121.8	276	28	246	31	0.0	0.0	4.08E-07	0.0	0.0	0.0	0.0
31	N	83	10	32	58	259	152.5	90.0	103.3	206	12	185	20	0.0	0.0	0.0	0.0	0.0	1.39E-10	0.0
31	N	83	10	33	8	244	152.2	90.0	103.8	207	12	185	20	0.0	0.0	0.0	0.0	0.0	1.44E-10	0.0
31	N	83	10	33	18	228	151.9	90.0	104.2	207	13	185	21	0.0	0.0	0.0	0.0	0.0	1.53E-10	0.0
31	N	83	10	33	28	213	151.6	90.0	104.7	208	13	186	21	0.0	0.0	0.0	0.0	0.0	1.76E-10	0.0
31	N	83	10	33	38	197	151.3	90.0	105.2	208	13	186	22	0.0	0.0	0.0	0.0	0.0	2.13E-10	0.0
31	N	83	10	33	48	131	151.0	90.0	105.7	209	14	186	22	0.0	0.0	0.0	0.0	0.0	2.41E-10	0.0
31	N	83	10	33	58	167	150.5	90.0	106.5	209	14	186	23	0.0	0.0	0.0	0.0	0.0	2.78E-10	0.0
31	N	83	10	34	8	151	150.2	90.0	107.1	210	15	186	24	0.0	0.0	0.0	0.0	0.0	3.47E-10	0.0
31	N	83	10	34	19	135	149.9	90.0	107.5	210	15	186	24	0.0	0.0	0.0	0.0	0.0	4.40E-10	0.0
31	N	83	10	34	28	119	149.5	90.0	108.1	211	15	186	25	0.0	0.0	0.0	0.0	0.0	4.26E-10	0.0
31	N	83	10	34	38	102	149.2	90.0	108.6	211	15	187	25	0.0	0.0	0.0	0.0	0.0	1.20E-09	0.0
31	N	83	10	34	48	86	148.8	90.0	109.1	212	16	187	26	0.0	0.0	0.0	0.0	0.0	3.06E-09	0.0
31	N	83	10	34	58	69	148.5	90.0	109.6	212	16	187	26	0.0	0.0	0.0	0.0	0.0	2.69E-09	0.0
31	N	83	10	35	8	53	148.1	90.0	110.1	213	16	187	27	0.0	0.0	0.0	0.0	0.0	1.50E-09	0.0
31	N	83	10	35	18	36	147.7	90.0	110.6	213	17	187	27	0.0	0.0	0.0	0.0	0.0	7.18E-10	0.0
31	N	83	10	35	28	20	147.3	90.0	111.2	214	17	187	28	0.0	0.0	0.0	0.0	0.0	5.88E-10	0.0
31	N	83	10	35	38	3	147.0	90.0	111.7	214	17	188	28	0.0	0.0	0.0	0.0	0.0	5.32E-10	0.0
31	N	83	10	35	48	0	149.2	86.2	108.7	215	18	192	28	0.0	0.0	0.0	0.0	0.0	4.58E-10	0.0
31	N	83	10	38	48	0	146.5	72.0	104.3	224	23	211	31	0.0	0.0	0.0	0.0	0.0	2.22E-10	0.0

RUN NO. D N 14 A2	DAY 14	GMT H 13	M 13	S 13	TAN ALT 14	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	CAO LON 14	CAO LAT 14	OBS LON 14	OBS LAT 14	1250A 1PE9.2	1380A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
31N	83	12	41	48	0	136.8	65.4	108.1	234	27	225	36	0.0	0.0	0.0	0.0	0.0	2.03E-10	0.0
32N	83	12	12	38	315	153.2	90.0	101.8	179	11	160	18	0.0	0.0	0.0	0.0	0.0	1.48E-10	0.0
32N	83	12	12	48	301	152.9	90.0	102.3	180	11	160	19	0.0	0.0	0.0	0.0	0.0	1.48E-10	0.0
32N	83	12	12	58	286	152.7	90.0	102.8	180	12	160	19	0.0	0.0	0.0	0.0	0.0	1.57E-10	0.0
32N	83	12	13	8	271	152.4	90.0	103.2	181	12	160	20	0.0	0.0	0.0	0.0	0.0	1.67E-10	0.0
32N	83	12	13	18	256	152.2	90.0	103.7	181	12	160	20	0.0	0.0	0.0	0.0	0.0	1.71E-10	0.0
32N	83	12	13	28	240	151.9	90.0	104.2	182	13	160	21	0.0	0.0	0.0	0.0	0.0	1.85E-10	0.0
32N	83	12	13	38	225	151.6	90.0	104.7	182	13	160	21	0.0	0.0	0.0	0.0	0.0	1.94E-10	0.0
32N	83	12	13	48	209	151.3	90.0	105.2	183	13	161	22	0.0	0.0	0.0	0.0	0.0	2.08E-10	0.0
32N	83	12	13	58	193	151.0	90.0	105.7	183	14	161	22	0.0	0.0	0.0	0.0	0.0	2.59E-10	0.0
32N	83	12	14	8	180	150.5	90.0	106.5	184	14	161	23	0.0	0.0	0.0	0.0	0.0	3.10E-10	0.0
32N	83	12	14	18	164	150.2	90.0	107.0	184	15	161	24	0.0	0.0	0.0	0.0	0.0	3.43E-10	0.0
32N	83	12	14	28	149	149.8	90.0	107.5	185	15	161	24	0.0	0.0	0.0	0.0	0.0	3.84E-10	0.0
32N	83	12	14	38	131	149.5	90.0	108.0	185	15	161	25	0.0	0.0	0.0	0.0	0.0	4.63E-10	0.0
32N	83	12	14	48	115	149.2	90.0	108.5	186	16	162	25	0.0	0.0	0.0	0.0	0.0	5.65E-10	0.0
32N	83	12	14	58	99	148.8	90.0	109.0	186	16	162	26	0.0	0.0	0.0	0.0	0.0	1.69E-09	0.0
32N	83	12	15	8	82	148.4	90.0	109.6	187	16	162	26	0.0	0.0	0.0	0.0	0.0	1.71E-09	0.0
32N	83	12	15	18	65	148.1	90.0	110.1	187	17	162	27	0.0	0.0	0.0	0.0	0.0	1.53E-09	0.0
32N	83	12	15	28	49	147.7	90.0	110.6	188	17	162	27	0.0	0.0	0.0	0.0	0.0	1.20E-09	0.0
32N	83	12	15	38	33	147.3	90.0	111.1	188	17	162	28	0.0	0.0	0.0	0.0	0.0	7.73E-10	0.0
32N	83	12	15	48	16	146.9	90.0	111.6	189	17	162	28	0.0	0.0	0.0	0.0	0.0	5.79E-10	0.0
32N	83	12	15	58	0	147.0	89.3	111.6	189	18	163	29	0.0	0.0	0.0	0.0	0.0	4.86E-10	0.0
32N	83	12	18	58	0	146.5	72.4	104.6	199	23	186	31	0.0	0.0	0.0	0.0	0.0	2.69E-10	0.0
32N	83	12	21	58	0	136.9	65.6	108.3	209	28	200	36	0.0	0.0	0.0	0.0	0.0	1.62E-10	0.0
33N	83	13	53	43	244	151.7	90.0	104.4	157	13	135	21	0.0	0.0	0.0	0.0	0.0	1.81E-10	0.0
33N	83	13	53	53	229	151.4	90.0	104.9	157	13	135	21	0.0	0.0	0.0	0.0	0.0	1.94E-10	0.0
33N	83	13	54	3	213	151.1	90.0	105.4	158	14	135	22	0.0	0.0	0.0	0.0	0.0	2.04E-10	0.0
33N	83	13	54	13	198	150.8	90.0	105.9	158	14	136	22	0.0	0.0	0.0	0.0	0.0	2.18E-10	0.0
33N	83	13	54	23	182	150.5	90.0	106.4	159	14	136	23	0.0	0.0	0.0	0.0	0.0	2.45E-10	0.0
33N	83	13	54	33	168	150.0	90.0	107.2	159	15	136	24	0.0	0.0	0.0	0.0	0.0	2.73E-10	0.0
33N	83	13	54	43	152	149.6	90.0	107.7	160	15	136	24	0.0	0.0	0.0	0.0	0.0	3.47E-10	0.0
33N	83	13	54	53	136	149.3	90.0	108.2	160	16	136	25	0.0	0.0	0.0	0.0	0.0	4.26E-10	0.0
33N	83	13	55	3	120	149.0	90.0	108.8	161	16	136	25	0.0	0.0	0.0	0.0	0.0	4.49E-10	0.0
33N	83	13	55	13	104	148.6	90.0	109.3	161	16	137	26	0.0	0.0	0.0	0.0	0.0	1.60E-09	0.0
33N	83	13	55	23	87	148.2	90.0	109.8	162	16	137	26	0.0	0.0	0.0	0.0	0.0	1.74E-09	0.0
33N	83	13	55	33	71	147.9	90.0	110.3	162	17	137	27	0.0	0.0	0.0	0.0	0.0	2.64E-09	0.0
33N	83	13	55	43	54	147.5	90.0	110.8	163	17	137	28	0.0	0.0	0.0	0.0	0.0	2.96E-09	0.0
33N	83	13	55	53	38	147.1	90.0	111.3	163	17	137	28	0.0	0.0	0.0	0.0	0.0	9.26E-10	0.0
33N	83	13	56	3	21	146.7	90.0	111.8	164	18	137	29	0.0	0.0	0.0	0.0	0.0	5.56E-10	0.0
33N	83	13	56	13	5	146.3	90.0	112.4	164	18	138	29	0.0	0.0	0.0	0.0	0.0	4.17E-10	0.0
33N	83	13	56	23	0	148.4	86.5	109.6	155	18	142	29	0.0	0.0	0.0	0.0	0.0	2.87E-10	0.0
33N	83	13	59	23	0	145.7	72.1	105.1	174	23	161	32	0.0	0.0	0.0	0.0	0.0	1.30E-10	0.0
34N	83	15	32	55	253	151.6	90.0	104.5	131	13	110	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34N	83	15	34	5	239	151.3	90.0	105.0	132	13	110	21	0.0	0.0	0.0	1.21E-11	0.0	0.0	0.0
34N	83	15	34	15	222	151.0	90.0	105.5	132	14	110	22	0.0	0.0	0.0	2.42E-11	0.0	0.0	0.0
34N	83	15	34	25	207	150.7	90.0	106.0	133	14	111	23	0.0	0.0	0.0	3.63E-11	0.0	0.0	0.0
34N	83	15	34	35	191	150.4	90.0	106.5	133	14	111	23	0.0	0.0	0.0	4.84E-11	0.0	0.0	0.0
34N	83	15	34	45	177	149.9	90.0	107.3	134	15	111	24	0.0	0.0	0.0	7.26E-11	0.0	0.0	0.0
34N	83	15	34	55	161	149.5	90.0	107.8	134	15	111	24	0.0	0.0	0.0	1.09E-10	0.0	0.0	0.0
34N	83	15	35	5	145	149.2	90.0	108.3	135	16	111	25	0.0	0.0	0.0	1.81E-10	0.0	0.0	0.0

RUN NO. I4 / D N A2	DAY I4	GMT H I3	GMT M I3	GMT S I3	TAN ALT I4	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	OAO LON I4	OAO LAT I4	CBS LON I4	CBS LAT I4	1250A 1PE9.2	1360A 1PE9.2	1500A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
34N	83	15	35	15	129	143.9	90.0	108.3	135	16	111	25	0.0	0.0	0.0	2.06E-10	0.0	0.0	0.0
34N	83	15	35	25	113	148.5	90.0	109.3	136	16	112	26	0.0	0.0	0.0	1.94E-10	0.0	0.0	0.0
34N	83	15	35	35	97	148.1	90.0	109.8	136	17	112	27	0.0	0.0	0.0	1.57E-10	0.0	0.0	0.0
34N	83	15	35	45	81	147.8	90.0	110.3	137	17	112	27	0.0	0.0	0.0	1.45E-10	0.0	0.0	0.0
34N	83	15	35	55	64	147.4	90.0	110.9	137	17	112	28	0.0	0.0	0.0	1.57E-10	0.0	0.0	0.0
34N	83	15	36	5	48	147.0	90.0	111.4	138	18	112	28	0.0	0.0	0.0	1.09E-10	0.0	0.0	0.0
34N	83	15	36	15	31	146.6	90.0	111.9	138	18	112	29	0.0	0.0	0.0	6.05E-11	0.0	0.0	0.0
34N	83	15	36	25	15	145.2	90.0	112.4	139	18	113	29	0.0	0.0	0.0	3.63E-11	0.0	0.0	0.0
34N	83	15	36	35	0	146.9	88.6	111.6	139	18	114	29	0.0	0.0	0.0	2.42E-11	0.0	0.0	0.0
34N	83	15	39	35	0	145.6	72.4	105.4	149	24	136	32	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34N	83	15	42	35	0	136.0	65.7	109.1	159	28	150	36	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35N	83	17	13	56	279	151.8	90.0	104.1	106	13	85	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35N	83	17	14	6	264	151.5	90.0	104.6	106	13	85	21	0.0	0.0	0.0	1.21E-11	0.0	0.0	0.0
35N	83	17	14	16	248	151.2	90.0	105.0	107	14	85	21	0.0	0.0	0.0	1.21E-11	0.0	0.0	0.0
35N	83	17	14	26	233	150.9	90.0	105.5	107	14	85	22	0.0	0.0	0.0	3.63E-11	0.0	0.0	0.0
35N	83	17	14	36	217	150.6	90.0	106.0	108	14	85	23	0.0	0.0	0.0	6.05E-11	0.0	0.0	0.0
35N	83	17	14	46	202	150.3	90.0	106.5	109	15	86	23	0.0	0.0	0.0	7.26E-11	0.0	0.0	0.0
35N	83	17	14	56	186	150.0	90.0	107.0	109	15	86	24	0.0	0.0	0.0	1.09E-10	0.0	0.0	0.0
35N	83	17	15	6	172	149.5	90.0	107.8	109	15	86	24	0.0	0.0	0.0	1.94E-10	0.0	0.0	0.0
35N	83	17	15	16	156	149.1	90.0	108.3	110	16	86	25	0.0	0.0	0.0	2.18E-10	0.0	0.0	0.0
35N	83	17	15	26	140	148.8	90.0	108.8	110	16	86	25	0.0	0.0	0.0	2.18E-10	0.0	0.0	0.0
35N	83	17	15	36	124	148.4	90.0	109.3	111	16	86	26	0.0	0.0	0.0	1.69E-10	0.0	0.0	0.0
35N	83	17	15	46	108	148.1	90.0	109.8	111	17	87	27	0.0	0.0	0.0	1.94E-10	0.0	0.0	0.0
35N	83	17	15	56	92	147.7	90.0	110.4	112	17	87	27	0.0	0.0	0.0	1.81E-10	0.0	0.0	0.0
35N	83	17	16	6	75	147.3	90.0	110.9	112	17	87	28	0.0	0.0	0.0	1.33E-10	0.0	0.0	0.0
35N	83	17	16	16	59	147.0	90.0	111.4	113	18	87	28	0.0	0.0	0.0	8.47E-11	0.0	0.0	0.0
35N	83	17	16	26	43	146.6	90.0	111.9	113	18	87	29	0.0	0.0	0.0	6.05E-11	0.0	0.0	0.0
35N	83	17	16	36	26	146.2	90.0	112.4	114	18	87	29	0.0	0.0	0.0	3.63E-11	0.0	0.0	0.0
35N	83	17	16	46	10	145.8	90.0	112.9	114	19	88	30	0.0	0.0	0.0	3.63E-11	0.0	0.0	0.0
35N	83	17	16	56	0	147.2	87.3	111.0	115	19	91	29	0.0	0.0	0.0	2.42E-11	0.0	0.0	0.0
35N	83	17	19	56	0	145.1	72.2	105.8	124	24	111	32	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35N	83	17	22	56	0	135.5	65.6	109.6	134	28	126	37	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36D	225	0	18	57	230	28.7	90.0	109.6	224	34	206	19	0.0	0.0	9.03E-08	7.18E-09	0.0	0.0	0.0
36D	225	0	19	7	206	29.0	90.0	109.9	225	35	207	19	0.0	0.0	1.35E-07	1.11E-08	0.0	0.0	0.0
36D	225	0	19	17	181	29.2	90.0	110.2	226	35	207	18	0.0	0.0	2.26E-07	1.90E-08	0.0	0.0	0.0
36D	225	0	19	27	156	29.5	90.0	110.6	227	35	207	18	0.0	0.0	3.46E-07	3.69E-08	0.0	0.0	0.0
36D	225	0	19	37	130	29.7	90.0	110.9	227	35	207	18	0.0	0.0	2.71E-07	7.27E-08	0.0	0.0	0.0
36D	225	0	19	47	104	30.0	90.0	111.2	228	35	207	18	0.0	0.0	1.50E-07	1.00E-07	0.0	0.0	0.0
36D	225	0	19	57	77	30.3	90.0	111.6	229	35	208	17	0.0	0.0	1.66E-07	9.99E-08	0.0	0.0	0.0
36D	225	0	20	7	50	30.5	90.0	111.9	229	35	208	17	0.0	0.0	1.66E-07	0.0	0.0	0.0	0.0
36D	225	0	20	17	23	30.8	90.0	112.3	230	35	208	17	0.0	0.0	1.66E-07	0.0	0.0	0.0	0.0
36D	225	0	20	27	0	32.6	87.8	114.6	231	35	210	18	0.0	0.0	1.66E-07	0.0	0.0	0.0	0.0
36D	225	0	20	37	0	35.5	84.2	118.1	231	35	213	21	0.0	0.0	1.66E-07	0.0	0.0	0.0	0.0
37D	225	3	38	53	296	27.9	90.0	109.4	172	34	155	20	0.0	1.72E-07	0.0	0.0	0.0	0.0	0.0
37D	225	3	39	3	273	28.1	90.0	108.9	173	34	156	19	0.0	1.72E-07	0.0	0.0	0.0	0.0	0.0
37D	225	3	39	13	250	28.3	90.0	109.1	174	34	156	19	0.0	1.72E-07	0.0	0.0	0.0	0.0	0.0
37D	225	3	39	23	226	28.6	90.0	109.4	174	35	156	19	0.0	2.59E-07	0.0	0.0	0.0	0.0	0.0
37D	225	3	39	33	202	28.8	90.0	109.8	175	35	156	19	0.0	4.31E-07	0.0	0.0	0.0	0.0	0.0
37D	225	3	39	43	177	29.1	90.0	110.1	176	35	156	18	0.0	5.17E-07	0.0	0.0	0.0	0.0	0.0
37D	225	3	39	53	152	29.3	90.0	110.4	176	35	157	18	0.0	7.76E-07	0.0	0.0	0.0	0.0	0.0

RUN NO. 14	N A2	DAY 14	GMT H 13	M 13	S 13	TAN ALT 14	SUN ANG F6.1	OBS ANG F6.1	SCAT ANG F6.1	RAD LON 14	RAD LAT 14	OBS LON 14	OBS LAT 14	1250A 1PE9.2	1360A 1PE9.2	1550A 1PE9.2	1920A 1PE9.2	2380A 1PE9.2	2460A 1PE9.2	2900A 1PE9.2
37	D	225	7	40	3	126	29.6	90.0	110.3	177	35	157	18	0.0	7.76E-07	0.0	0.0	0.0	0.0	0.0
37	D	225	7	40	13	100	29.9	90.0	111.1	178	35	157	18	0.0	6.04E-07	0.0	0.0	0.0	0.0	0.0
37	D	225	7	40	23	74	30.1	90.0	111.4	175	35	157	17	0.0	5.17E-07	0.0	0.0	0.0	0.0	0.0
37	D	225	7	40	33	47	30.4	90.0	111.8	179	35	158	17	0.0	5.17E-07	0.0	0.0	0.0	0.0	0.0
37	D	225	7	40	43	20	30.7	90.0	112.1	180	35	158	17	0.0	5.17E-07	0.0	0.0	0.0	0.0	0.0
37	D	225	7	40	53	[illegible]	33.0	87.1	115.1	180	35	160	19	0.0	5.17E-07	0.0	0.0	0.0	0.0	0.0
38	N	148	7	34	15	22	124.0	90.0	144.7	212	23	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	1.59E-09
38	N	148	7	34	16	25	124.1	90.0	144.7	212	24	240	34	0.0	0.0	1.26E-08	0.0	0.0	0.0	1.68E-09
38	N	148	7	34	17	28	124.1	90.0	144.7	212	24	240	34	0.0	0.0	0.0	0.0	0.0	0.0	1.78E-09
38	N	148	7	34	18	32	124.1	90.0	144.7	212	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	1.93E-09
38	N	148	7	34	19	35	124.1	90.0	144.7	212	24	240	34	0.0	0.0	0.0	0.0	0.0	0.0	2.21E-09
38	N	148	7	34	20	38	124.1	90.0	144.5	212	24	240	34	0.0	0.0	1.26E-08	0.0	0.0	0.0	2.52E-09
38	N	148	7	34	21	41	124.1	90.0	144.5	212	24	240	34	0.0	0.0	0.0	0.0	0.0	0.0	2.80E-09
38	N	148	7	34	22	45	124.1	90.0	144.5	212	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	3.09E-09
38	N	148	7	34	23	48	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	3.46E-09
38	N	148	7	34	24	51	124.1	90.0	144.5	213	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	3.83E-09
38	N	148	7	34	25	55	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	0.0	0.0	0.0	4.30E-09
38	N	148	7	34	26	58	124.1	90.0	144.6	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	4.96E-09
38	N	148	7	34	27	61	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	5.42E-09
38	N	148	7	34	28	64	124.1	90.0	144.6	213	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	5.95E-09
38	N	148	7	34	29	67	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	3.88E-10	0.0	0.0	6.83E-09
38	N	148	7	34	30	71	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	8.70E-09
38	N	148	7	34	31	74	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	3.88E-10	0.0	0.0	1.05E-08
38	N	148	7	34	32	77	124.1	90.0	144.5	213	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	1.08E-08
38	N	108	7	34	33	80	124.1	90.0	144.6	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	9.16E-09
38	N	148	7	34	34	83	124.1	90.0	144.6	213	24	240	34	0.0	0.0	0.0	0.0	0.0	0.0	5.98E-09
38	N	148	7	34	35	87	124.1	90.0	144.5	213	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	3.46E-09
38	N	148	7	34	36	90	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	0.0	0.0	0.0	1.40E-09
38	N	148	7	34	37	93	124.1	90.0	144.5	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	8.04E-10
38	N	148	7	34	38	96	124.1	90.0	144.6	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	5.98E-10
38	N	148	7	34	39	99	124.1	90.0	144.5	213	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	4.67E-10
38	N	148	7	34	40	102	124.2	90.0	144.6	213	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	4.30E-10
38	N	148	7	34	41	106	124.2	90.0	144.5	213	24	240	34	0.0	0.0	1.26E-08	0.0	0.0	0.0	4.30E-10
38	N	148	7	34	42	109	124.2	90.0	144.5	214	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	4.30E-10
38	N	148	7	34	43	112	124.2	90.0	144.5	214	24	240	34	0.0	0.0	1.26E-08	1.94E-10	0.0	0.0	4.30E-10
38	N	148	7	34	44	115	124.2	90.0	144.5	214	24	240	34	0.0	0.0	0.0	1.94E-10	0.0	0.0	4.30E-10

DATA ANALYSIS

A major problem in comparing various airglow measurements is that of reducing the results to some common basis by eliminating the angular dependence of the measurements. The angles on which these measurements depend are the solar zenith angle, θ, and the line of sight zenith angle, φ. The common basis usually chosen for comparison is the case in which both of these angles are zero. It was shown in Eq. (5) that the total received radiation is given by

$$I_T = \alpha \int_{s=0}^{\infty} I(s)T(s)ds \tag{5}$$

According to Beer's law, the atmospheric transmission, $T(s)$, can be expressed as

$$T(s) = \exp\left[- \sum_i \sigma_i N_i(s)\right] \tag{7}$$

where

σ_i = absorption cross section of the i^{th} atmospheric constituent

$N_i(s)$ = total number of particles per unit area of the i^{th} constituent between the point s and the detector

By definition,

$$N_i(s) = \int_{t=s}^{\infty} n_i(t)dt \tag{8}$$

where $n_i(t)$ is the number density of the i^{th} constituent along the line of sight vector.

Since most atmospheric quantities are expressed as functions of altitude along the local vertical, we make the transformation

$$ds = dy \sec \varphi_y \tag{9}$$

where φ_y is the angle between the line of sight and the local vertical at an altitude of y kilometers. The total received radiation is given by

$$I_T = \alpha \int_{y=0}^{\infty} I(y) \exp\left[- \sum_i \sigma_i \int_{t=y}^{\infty} n_i(t) \sec \varphi_t dt \right] \sec \varphi_y dy \tag{10}$$

From Fig. 8 it can be seen that

$$\sec \varphi_y = \left[1 - \left(\frac{R_e}{R_e + y} \right)^2 \sin^2 \varphi_o \right]^{-\frac{1}{2}} \tag{11}$$

When the line of sight does not intersect the earth, the $s = 0$ location is taken to be the tangent altitude point. This point indicates where the line of sight vector makes its closest approach to the earth. In this case, the total received radiation can be expressed as

$$I_T = \int_{y_h}^{\infty} [\cdot] T(y,\infty) dy + \int_{y_h}^{\infty} [\cdot] \left[T'(y_h,y) + T'(y_h,\infty) \right] dy \tag{12}$$

where

$[\cdot]$ = $\alpha I(y) \sec \varphi_y$

y_h = tangent altitude

$T'(a,b)$ = transmission of solar energy from point a to point b

and $T'(A,b)$ has the same definition except that φ_t is always greater than 90 degrees.

In the expressions given above, $I(y)$ is the volume emission rate of the atmosphere at the height y. This volume emission rate can be produced by several phenomena. For the analysis of our data, however, we believe that only two sources of radiation are important — Rayleigh scattering and photoelectron excitation.

For a Rayleigh scattering atmosphere, the theory is well known (Ref. 6) and we have

$$I(y,\lambda) = \frac{3}{16\pi} k_s (1 + \cos^2\psi)\rho(y)H(\lambda)T(y,\theta_y) \tag{13}$$

where

k_s = Rayleigh scattering coefficient (cm^{-1})

ψ = Rayleigh scattering angle

θ_y = angle between the sun line and the local vertical at the altitude y

$\rho(y)$ = total atmospheric number density at an altitude $h(cm^{-3})$

$H(\lambda)$ = solar irradiance at the top of the atmosphere at the wavelength $\lambda(w/cm^2)$

$T(y,\theta_y)$ = transmission of the solar energy from the top of the atmosphere to the altitude y

The term $H(\lambda)T(y,\theta_y)$ is the amount of solar energy of wavelength λ that reaches an altitude y along the slant path described by θ_y. The other term, $\frac{3}{16\pi} k_s(1 + \cos^2\psi)\rho(y)$, describes how much of this transmitted energy is electromagnetically scattered along the line of sight vector.

When the radiation is the result of photoelectron excitation, the volume emission rate is theoretically given by (Refs. 9,10)

$$I(y,\lambda) = \sum_{\ell}\sum_{j} \beta_{kj} r_{j\ell} f_j \tag{14}$$

where

k = the electronic state from which the transition to the ground state produces radiation of wavelength λ

β_{kj} = branching ratio or probability of a transition from the state j to the state k

f_j = the fraction of depopulations of the state j that produces radiation

$r_{j\ell}(y,\theta)$ = the rate of population of the j^{th} state of the ℓ^{th} species

The rate of population of the j^{th} state is proportional to the amount of energy lost during a collision with a photoelectron of energy E_p, and, therefore, is also proportional to the number of such photoelectrons produced by solar ionization. Thus, we have

$$r_{j\ell} = \int_{E_p > E_j} Q_p \times E_{j\ell} \tag{15}$$

where

$Q_p(y,\theta)$ = production rate of photoelectrons with energy E_p

$E_{j\ell}$ = energy deposited in the j^{th} state through a collision with an electron of energy E_p

The production rate of photoelectrons can be given as

$$Q_p(y,\theta) = \sum_i \sum_\ell \sigma_{i\ell}(\lambda_p) n_\ell(y) H(\lambda_p) \exp\left[- \sum_m \sigma_m \int_y^\infty n_m(t) \sec \theta_t \, dt \right] \tag{16}$$

where

$\sigma_{i\ell}$ = cross section for the i^{th} ionization state of the ℓ^{th} species

n_ℓ = particle density of the ℓ^{th} species

Obviously this relationship is complicated and many of the variables, such as the absorption and collision cross sections, are not known precisely. A complete investigation at this level is beyond the scope of this study. From the limb measurements, we have found that the emission rate follows an altitude profile with a peak near 175 kilometers. Therefore, I(y) can be approximated by a general distribution function of the form

$$I(y) = I_p \frac{(1 + a^2)e^{(y-y_p)/h}}{\left(a + e^{(y-y_p)/h}\right)^2} \tag{17}$$

The parameters a, h, y_p and I_p must be adjusted so that the predicted irradiance matches th measured values.

The practical application of the theories given above can only be accomplished with the assistance of high speed electronic computers. For this reason, several computer programs were devised in 1970 to allow us adequate flexibility in the data analysis. In these computer programs, we only consider atmospheric absorption by ozone and molecular oxygen. Table 6 gives the parameters for the various distributions (concentrations versus altitude, etc.) used in the programs. These distributions represent a 600°K model atmosphere that matched the density measurements obtained by Hayes and Robles (Ref. 16) using the WEP. The values of the absorption coefficients and the solar flux used in the programs were obtained from published data (Refs. 12,13,16). All wavelength dependent parameters are averaged over 50Å intervals. The spectral shapes of the WEP are also incorporated into the program.

Using the WEP filter curves, the expected outputs of the photometers are calculated by averaging over the effective half bandwidths of the filters. Thus, if $S_{ij}(\lambda)$ is the filter shape of the j^{th} filter on photometer i, then

Table 6

DISTRIBUTION PARAMETERS

General Distribution Function

$$x(y) = \frac{(1 + a)e^{(y-y_p)/h_a}}{\left(a + e^{(y-y_p)/h_a}\right)^2}$$

Distributions

LBH Radiation

$a = 1.0$

$y_p = 175$ km

$h = 25$ km

O_2 Density

$y < 163$ km	$a = .3594$
	$y_p = 0$
	$h = -5.9$ km
$y > 163$ km	$a = -.9999469$
	$y_p = 0$
	$h = -31$

O_3 Density

$a = 0$

$y_p = 23.5$ km

$h = -4.63$	$y < 23.5$ km
$+4.63$	$y > 23.5$ km

Total Atmosphere

$y < 150$ km	$a = 5.0$
	$y_p = 0$
	$h = -7.057$
$y > 150$ km	$a = -.99992$
	$y_p = 0$
	$h = -62.04$

$$I_{ij} = \frac{1}{B_{ij}} \int_{\lambda=0}^{\infty} S_{ij}(\lambda) I_T(\lambda) d\lambda \tag{18}$$

$$= \frac{1}{B_{ij}} \left[50\text{Å} \times \sum_k S_{ij}(\Delta_k + 1000\text{Å}) I_T(\Delta_k + 1000\text{Å}) \right] \tag{19}$$

where

B_{ij} = the effective half bandwidth of the j^{th} filter of photometer i

Δ_k = 50Å intervals

The inputs to this particular program are the tangent altitude and the three angles φ_o (line of sight zenith angle), θ_o (sun zenith angle), and ψ (scattering angle) all measured at the earth's surface or at the tangent altitude point. These quantities are provided by another Grumman program that gives a complete analysis of the OAO viewing geometry during the observation periods. The output of the program is the expected irradiance at 50Å intervals produced by both Rayleigh scattering and photoelectron excitation. Also given are the irradiance values expected to be obtained from the WEP filter photometers.

For each measurement sequence, a series of theoretical irradiance values was calculated. Parameters in the program were then varied until the theoretically predicted sequence matched the measured values. The irradiance was then calculated using these parameters for the case when both the viewing and the solar zenith angles were zero. This zero-zero case is used to compare the results of other experimenters.

The variation of the received radiation as the viewing area scans across the earth during a typical measurement sequence is shown in Figs. 5-7. In each of these sequences, the OAO field of view initially moves across the dark earth onto the sunlit earth and then through the sunlit limb and onto the star. The radiation increases rather sharply as the viewing moves across the sunlit earth. This is the result of the particular viewing geometry

associated with all these observations. During this portion of the scan, the solar zenith angle, θ, was decreasing and the line of sight zenith angle, φ, was increasing as shown in Fig. 9. The first effect means that less solar radiation is absorbed by higher altitude constituents. The second effect results in measurements of greater amounts of sunlit atmosphere as the viewing moves across the earth. Measurements during this same sequence of the dayglow in the 1920Å region are shown in Fig. 6. Notice that these measurements do not show the sharp maximum in received radiation.

These measurements have been reduced to the case when both the sun and the line of sight lie along the local zenith ($\theta = 0°$, $\varphi = 0°$). This provides a common basis from which the WEP measurements can be compared to theoretical predictions and results of other experiments. The radiances for this case, averaged over five orbits, are plotted in Fig. 10 for each filter. Also shown are the radiance values predicted by the Rayleigh scattering calculation. Note that only the values in the vacuum ultraviolet are shown since the dayglow saturated all WEP photometers using filters above 2000Å. Figure 10 shows that the only measurements that agree with the Rayleigh scattering prediction are those in the 1920Å spectral band. These measurements also agree with the results of Barth and Mackey (Ref. 1) and Elliott et al. (Ref. 17).

The spectral region covered by the 1500Å photometer is of particular interest. The measurements in this region agree with the data from the NRL experiment on OGO·4 and clearly indicate that the very low estimate of the earth's radiance predicted by Rayleigh scattering does not exist. The high level of radiation in the 1500Å region is believed to be the result of electronic excitation of molecular nitrogen by high energy photoelectrons (> 7 eV). These photoelectrons are produced from the ionization of high altitude atmospheric constituents by the extreme ultraviolet solar radiation. The principal emissions are from the Lyman-Birge-Hopfield $\left(a'\pi_g - x'\ \Sigma_g^+\right)$, Birge Hopfield $\left(b'\pi_u - x'\ \Sigma_g^+\right)$ and Vegard-Kaplan $\left(A^3\ \Sigma_u^+ - x'\ \Sigma_g^+\right)$ bands of molecular nitrogen. These transitions produce radiation in the 1350 to 1800Å spectral region. This mechanism was first considered theoretically by Barth and Green (Ref. 9) and later by Dalgarno et al. (Ref. 10). Prinz and Meier (Ref. 11) of NRL have used some of the more recent measurements of ionization cross sections, photoelectron collision cross sections, and quenching coefficients in determining the expected emissions from this mechanism. Their calculation

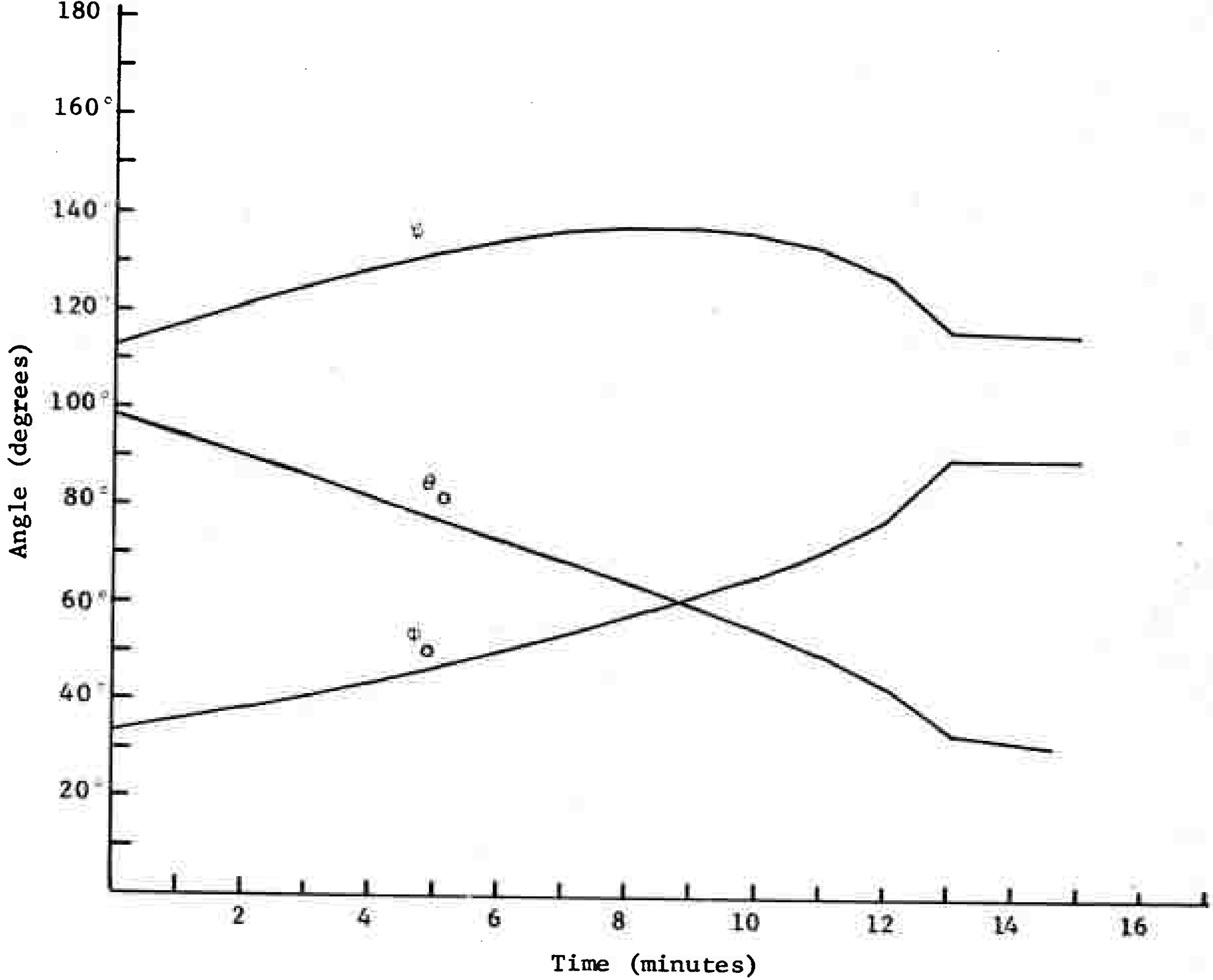

Fig. 9 Variation of Angles for Orbit 7903

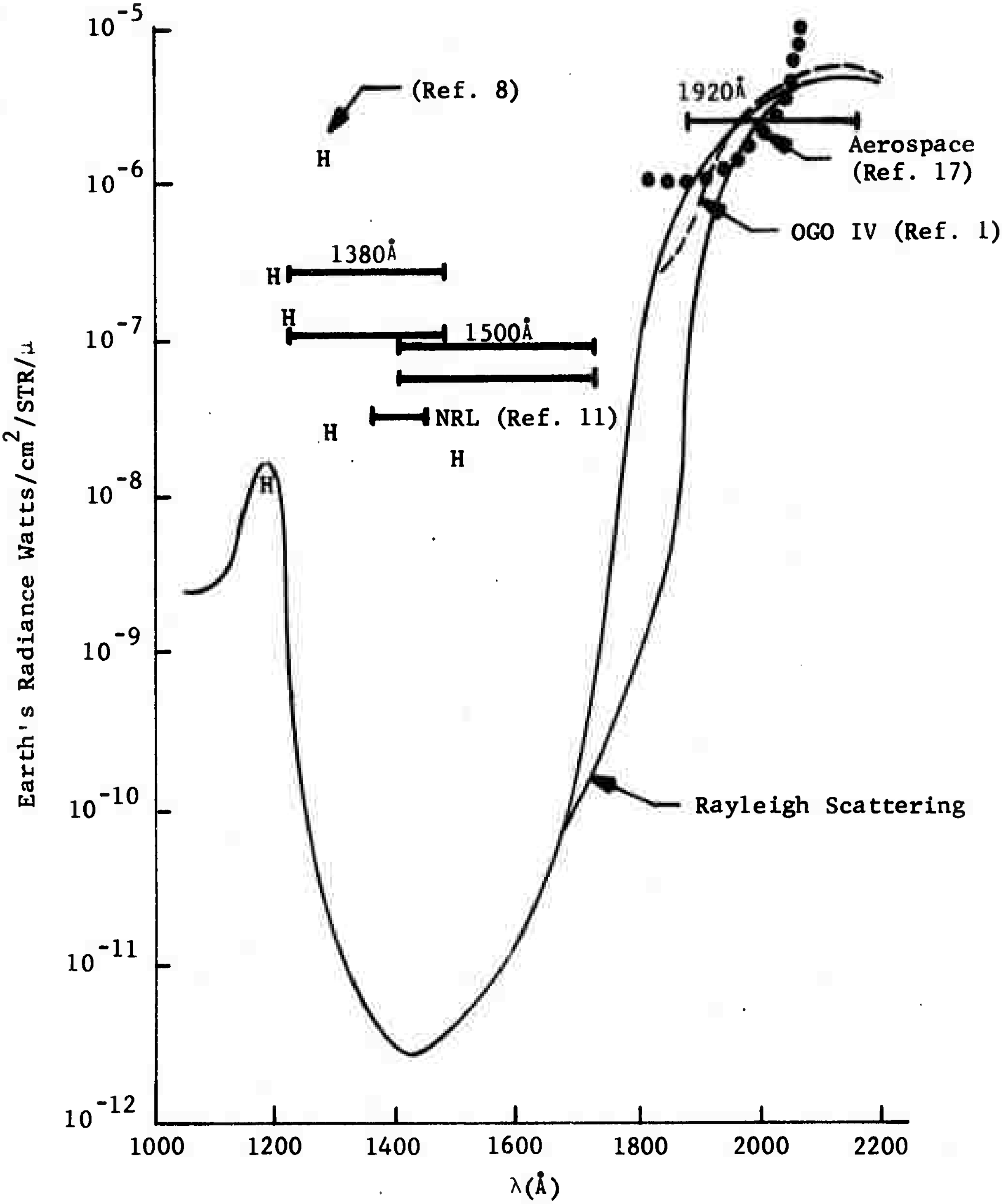

Fig. 10 Comparison of OAO Measurements with Other Experimental Measurements. Values are for 1380Å, 1500Å, and 1920Å Filters. Lower line represents the measured value minus the expected contribution of the 1304Å oxygen line.

predicts that the columnar emission rate from this system should be 6.5 kR or 3.3×10^{-8} w/cm^2-ster-μ between 1350 and 1800Å. They also indicate that a peak in the emission rate should exist near 180 kilometers.

Detailed measurements of the sunlit limb with the 1500Å filter and using the half second sampling mode of the WEP, are shown in Fig. 11. These measurements show a sharp peak in the received radiation near a tangent altitude of 175 kilometers. Because of the small field of view of the WEP photometers, it is reasonable to assume that the volume emission rate also has a maximum near 175 kilometers. The gaps in measurements, as shown in Fig. 11, are due to the delay in the issuance of new exposure commands. It should be noted that part of the radiation measured by the 1500Å filter is due to the emission from the 1304Å triplet of atomic oxygen. Assuming that the strength of this line is approximately 4×10^{-9} w/cm^2-ster as measured by Barth and Schaffner (Ref. 2), then this represents only 4 percent of the measured energy. Because of the near zero transmission of the 1500Å filter at 1200Å, the Lyman alpha emission of atomic hydrogen also does not contribute to radiation measured by this filter. Therefore, the only radiation of significance is that produced by the LBH bands of N_2. The variation of the 1500Å radiation with tangent altitude is shown in Figs. 12-14. It also should be noted that the radiance value given in Fig. 10 for the 1500Å measurements is an approximate value since the model chosen for the nitrogen emissions did not include the effects of the solar angle.

The measurements with the 1920Å filter, as mentioned, agree very well with values predicted by the Rayleigh scattering model. Results of the measurements of the sunlit limb using this filter are shown in Fig. 15. It can be seen that no large peak in the received radiation occurs as a function of tangent altitude in this wavelength region.

The radiation measured by the 1250Å filter is almost entirely due to the Lyman alpha emissions of atomic hydrogen at 1216Å. Part of the radiation can be attributed to the 1304 and 1356Å lines of atomic OI and also to the 1358Å LBH band of N_2. Although no detailed measurements, using half second sampling, of the sunlit limb were made at 1250Å, a good picture of the limb was obtained with the Mode C measurements. As shown in Fig. 16, the 1250Å radiation also shows a peak in the received radiation near 175 kilometers. It should be noted that radiation in this spectral region is very dependent on solar activity, explaining the spread in measured values.

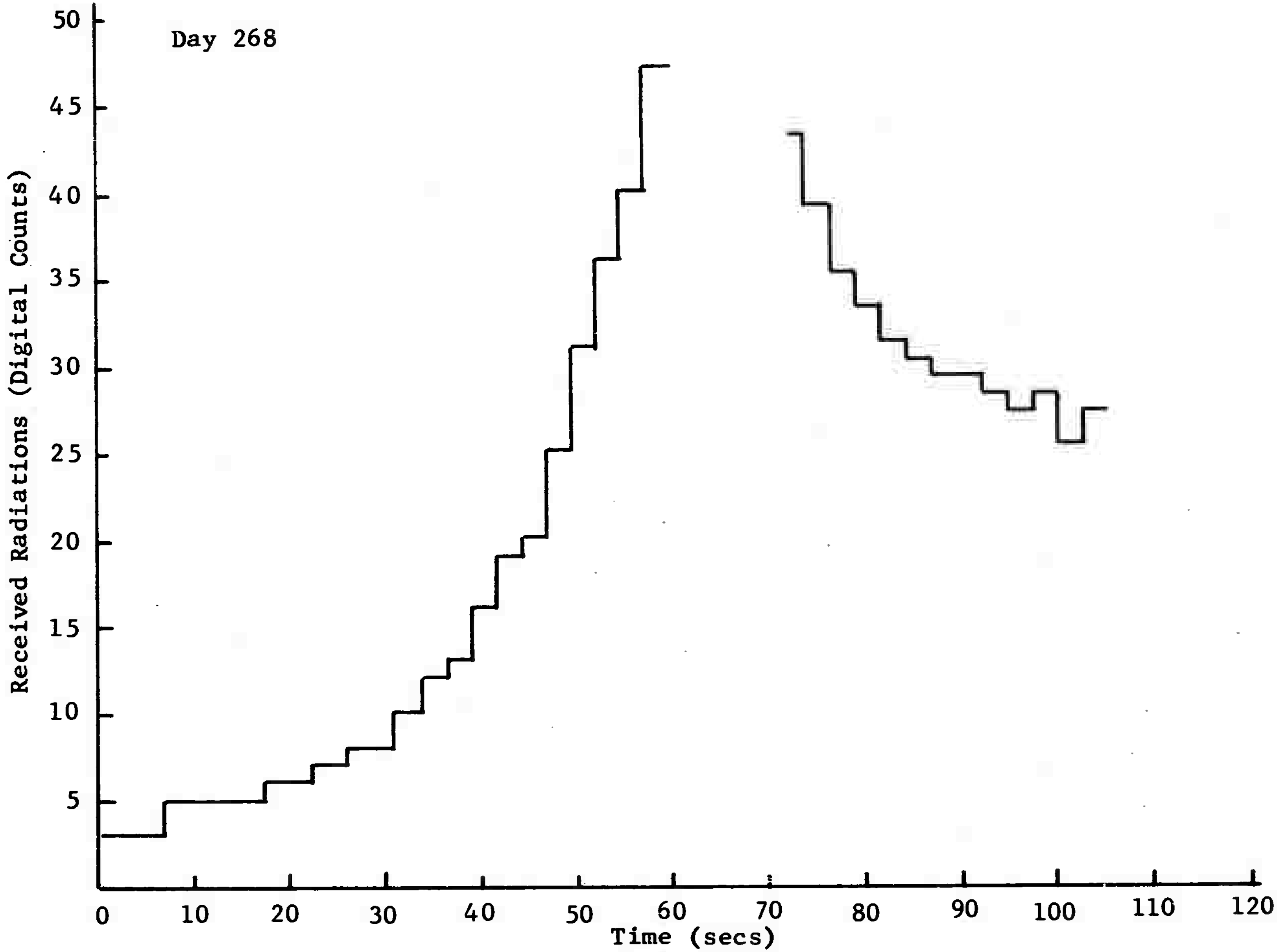

Fig. 11 1500Å Limb Measurement

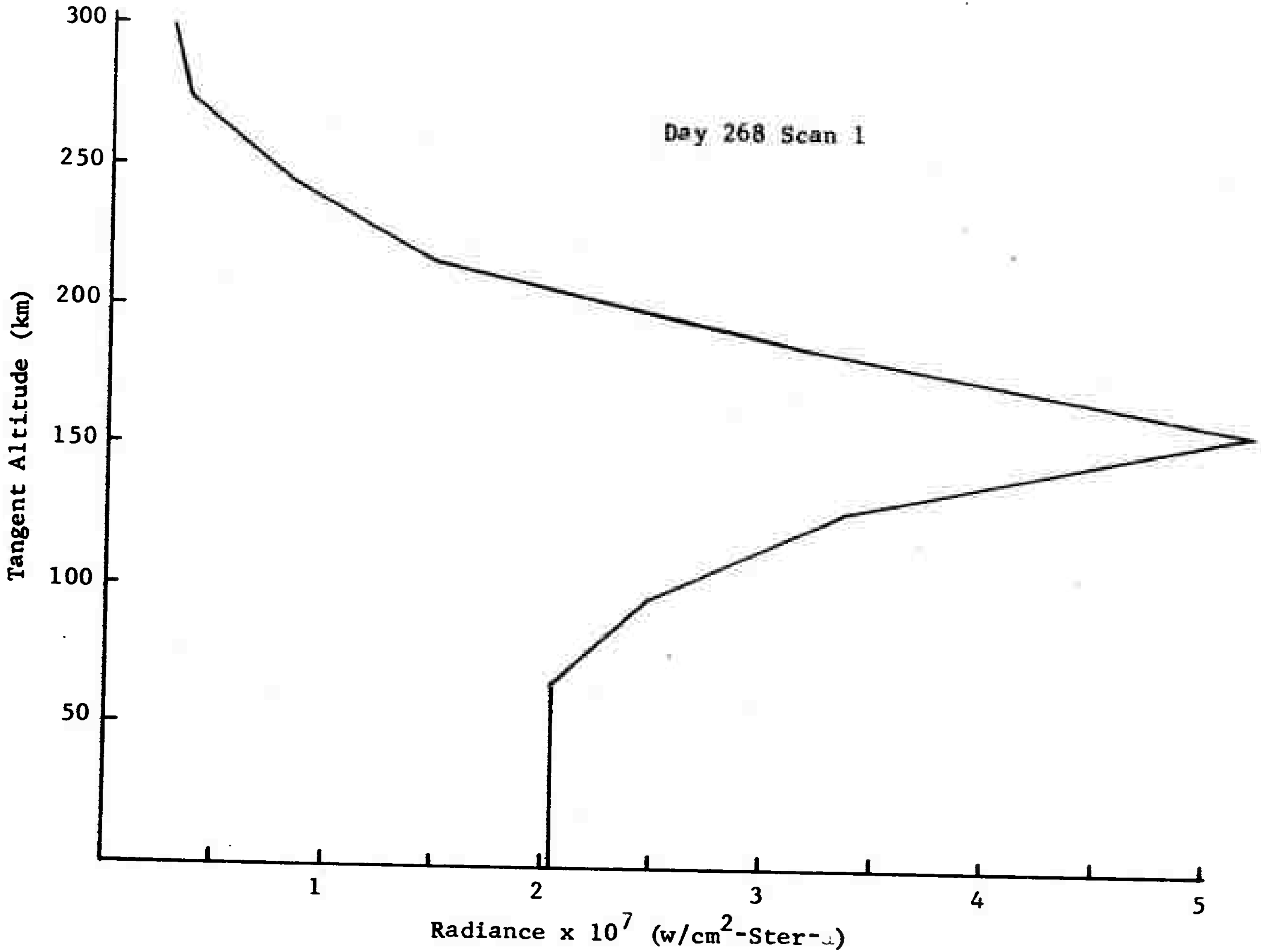

Fig. 12 Altitude Profile of 1500Å Radiation

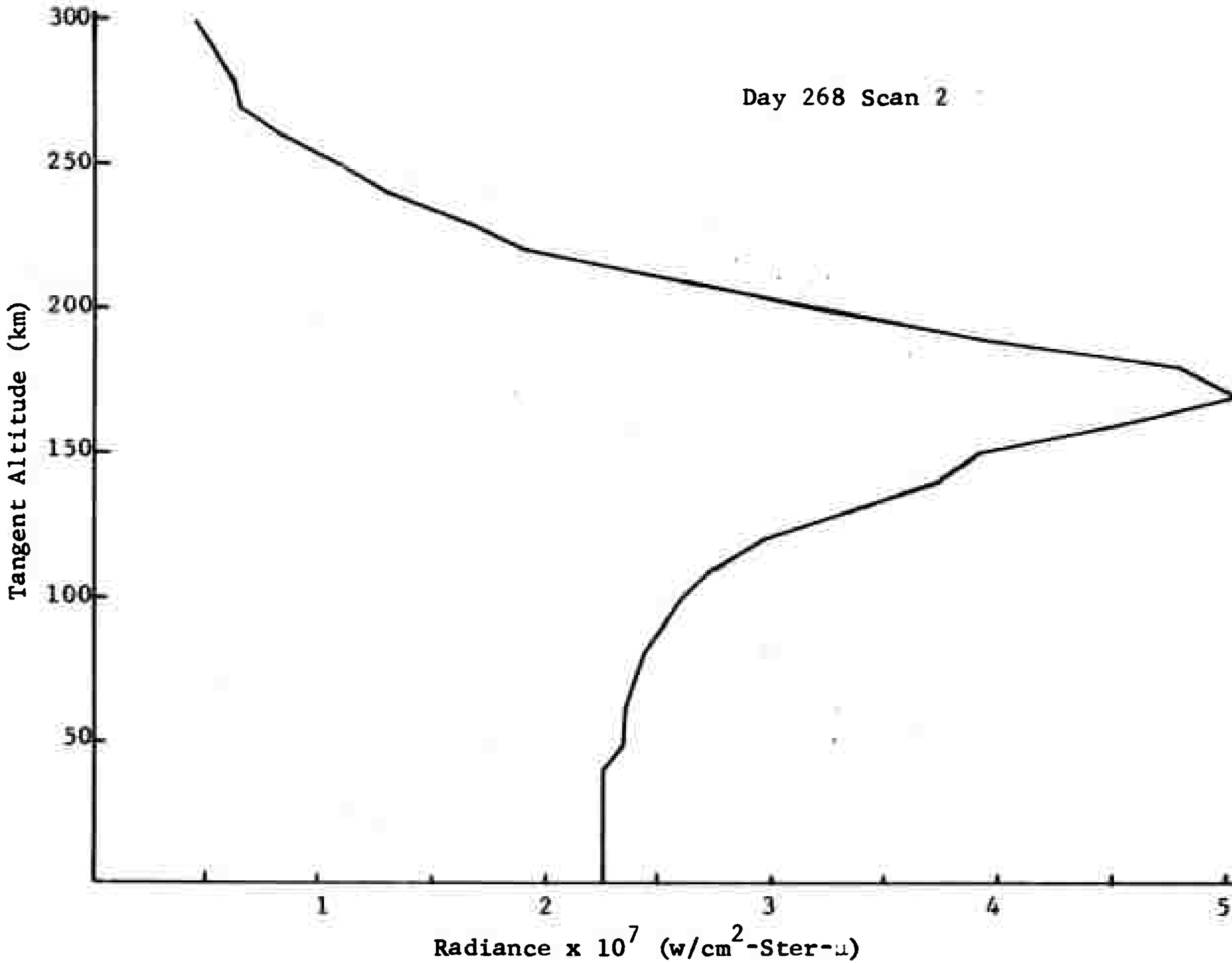

Fig. 13 Altitude Profile of 1500Å Radiation

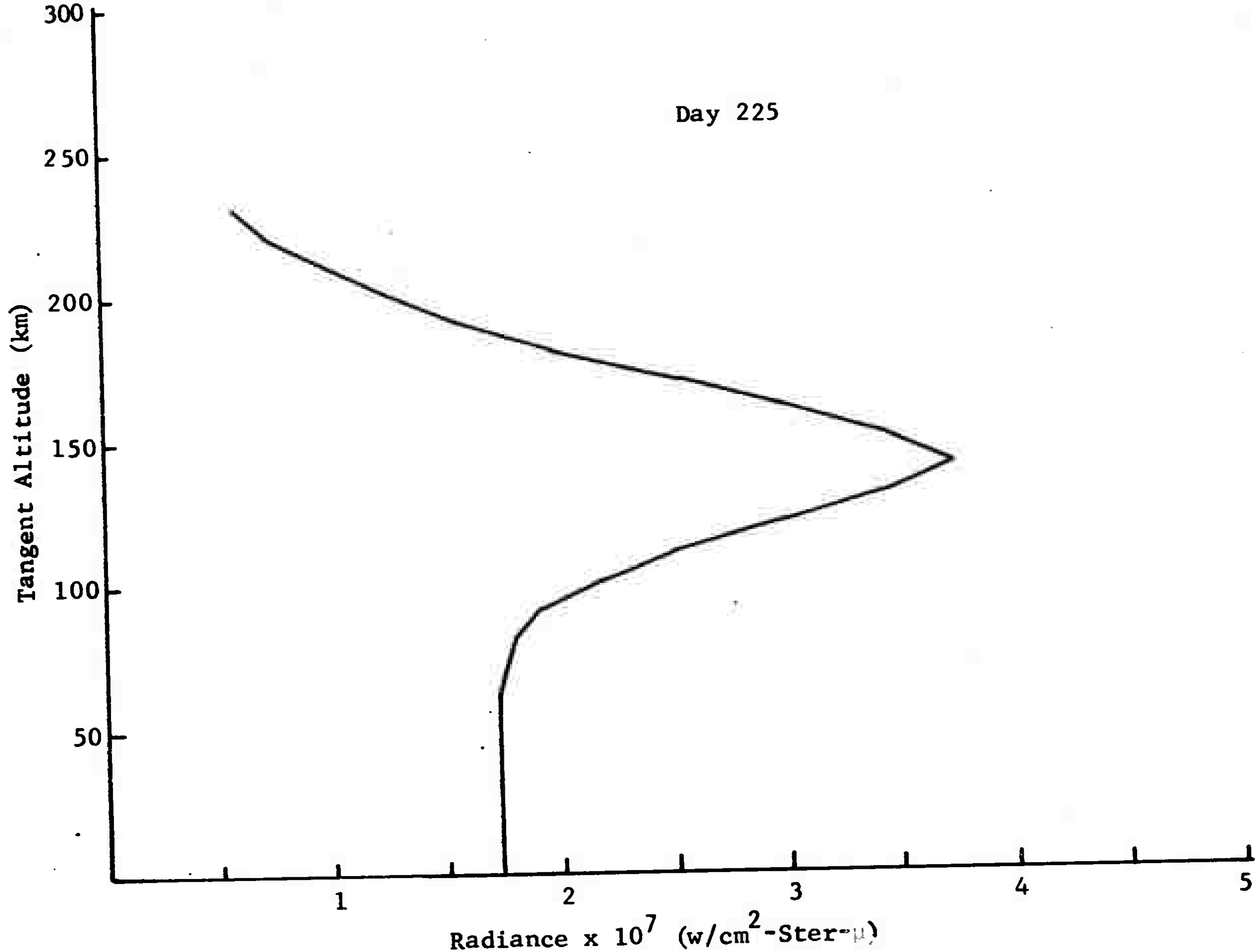

Fig. 14 Altitude Profile of 1500Å Radiation

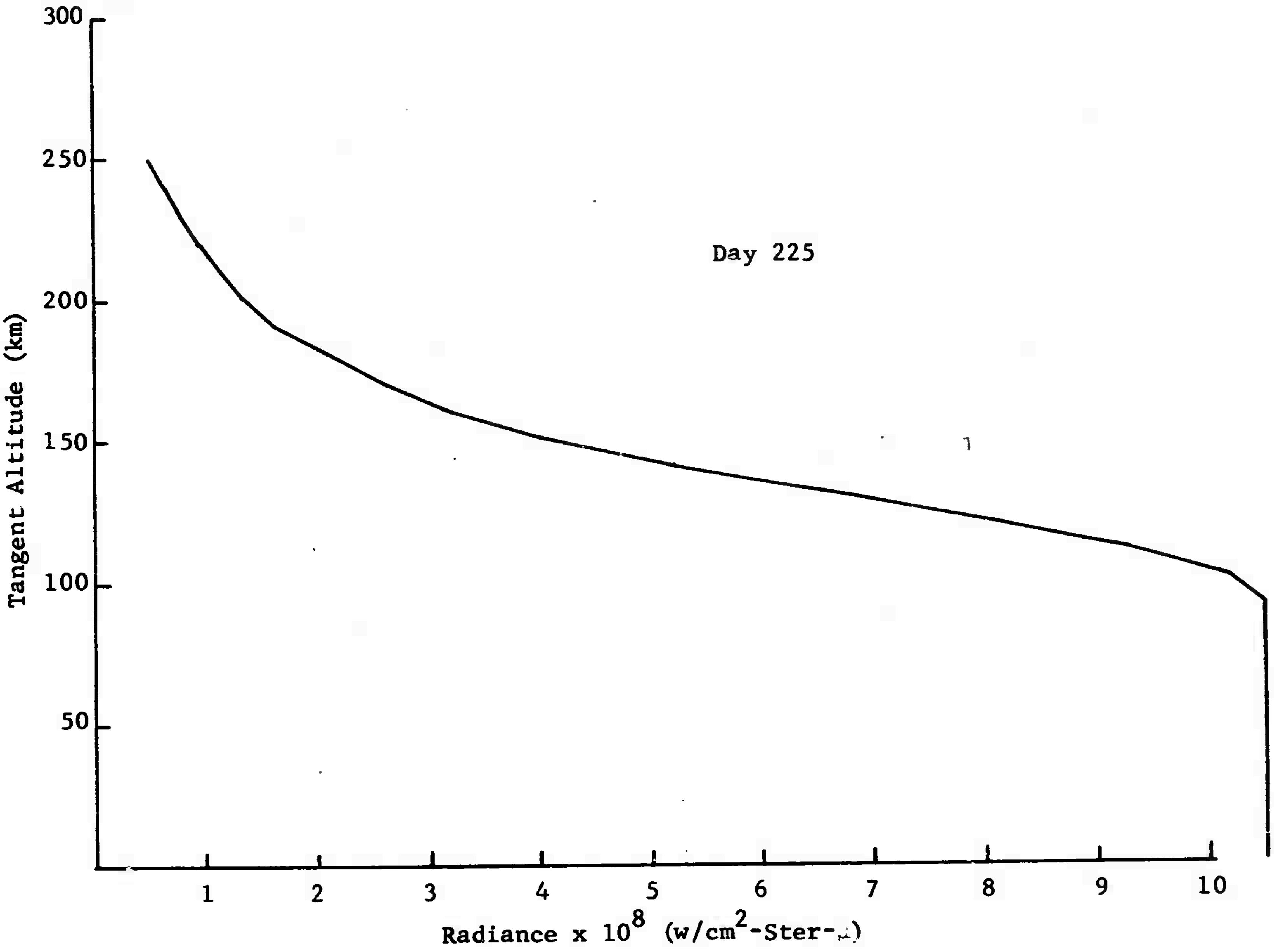

Fig. 15 Altitude Profile of 1920Å Radiation

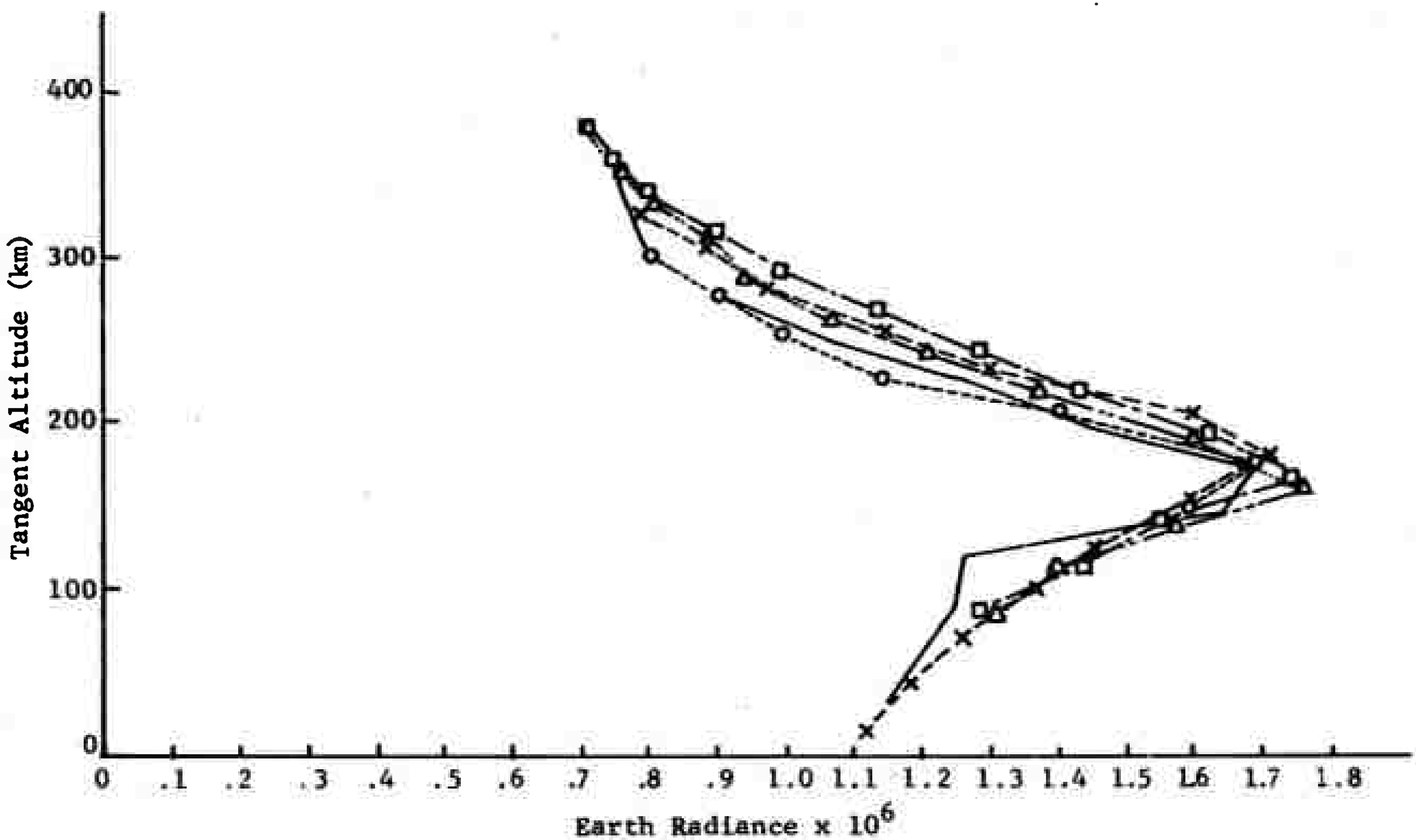

Fig. 16 Altitude Profile of 1250Å Radiation

The vacuum ultraviolet nightglow is barely a measurable feature. The measurements, using the 1250Å filter, show the radiance to be independent of altitude with a magnitude of about 10^{-8} w/cm^2 ster-μ, which is slightly above the noise level of the photometer. The source of this radiation was postulated by Meier (Ref. 4) to be scattered Lyman alpha emission from the sunlit portions of the upper atmosphere. The output from the 1500Å filter was at the noise level of the photometer for all nightglow measurements. This noise level is equivalent to an irradiance of 4.8×10^{-14} w/cm^2-μ. In the 1920Å region, the nightglow was measurable. The limb measurements showed a distinct altitude profile to the emission, as is shown in Fig. 17, with a peak in the received radiation occurring at a tangent altitude of about 70 kilometers. A similar spike in the nightglow was measured by Stecher (Ref. 15) at 1800Å. At present, the source of this radiation has not been identified. The prominent features of the ultraviolet nightglow occurred in the spectral region measured by the 2380 and 2980Å filters. The emissions measured by the 2980Å filter show a sharp peak occurring near 110 kilometers (Fig. 18). This maximum was also observed by Stecher (Ref. 15) and later by Hennes (Ref. 14). Their rocket spectrometers show the peak occurring near 97 kilometers. The spectrum obtained by both experiments indicate that the source of the radiation are the Herzberg bands of molecular oxygen. This band system produces emissions between 2500 and 3500Å. The most prominent feature of the spectrum is the large maximum near 3000Å produced by the Herzberg (7,4) and (5,3) bands at 2976 and 2945Å and by the 2972Å line of atomic oxygen. Figure 19 shows the altitude profile of the received radiation from the 2380Å filter and Fig. 20 shows the radiation measured by the 2460Å filter. These measurements also show a peak near 110 kilometers and, therefore, are probably measuring some of the lower wavelength bands of the Herzberg system.

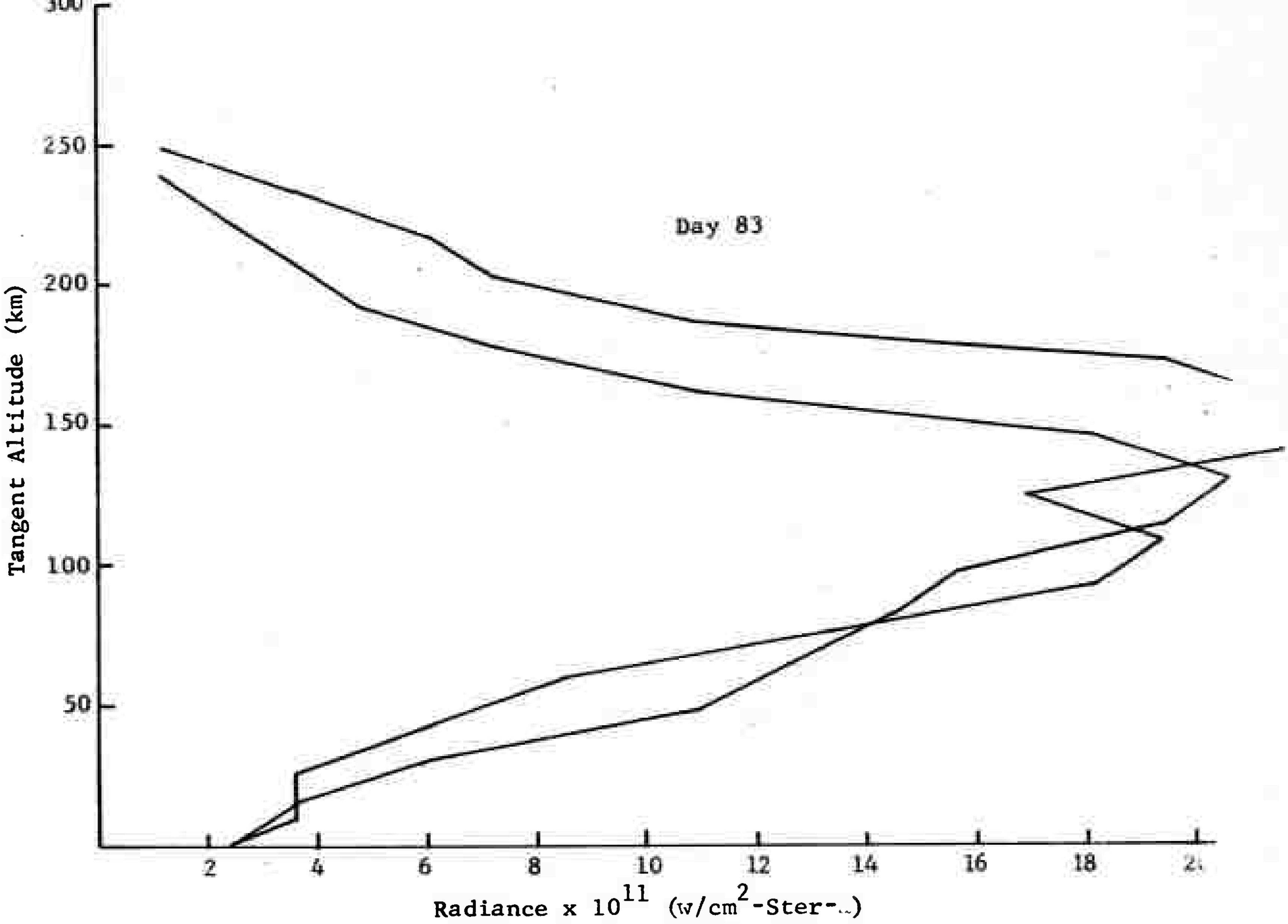

Fig. 17 Altitude Profile of the 1920Å Nightglow

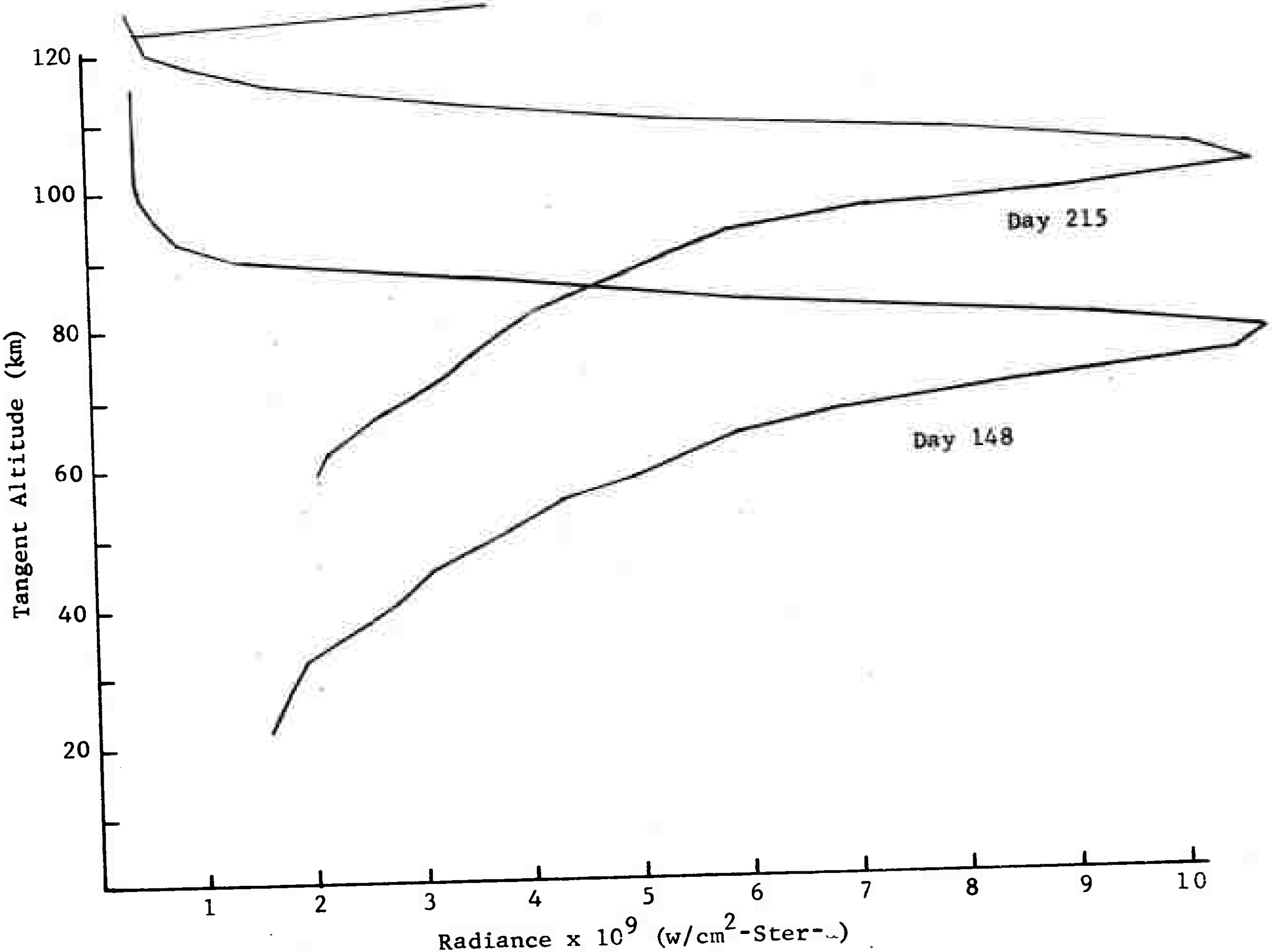

Fig. 18 Altitude Profile of the 2980Å Nightglow

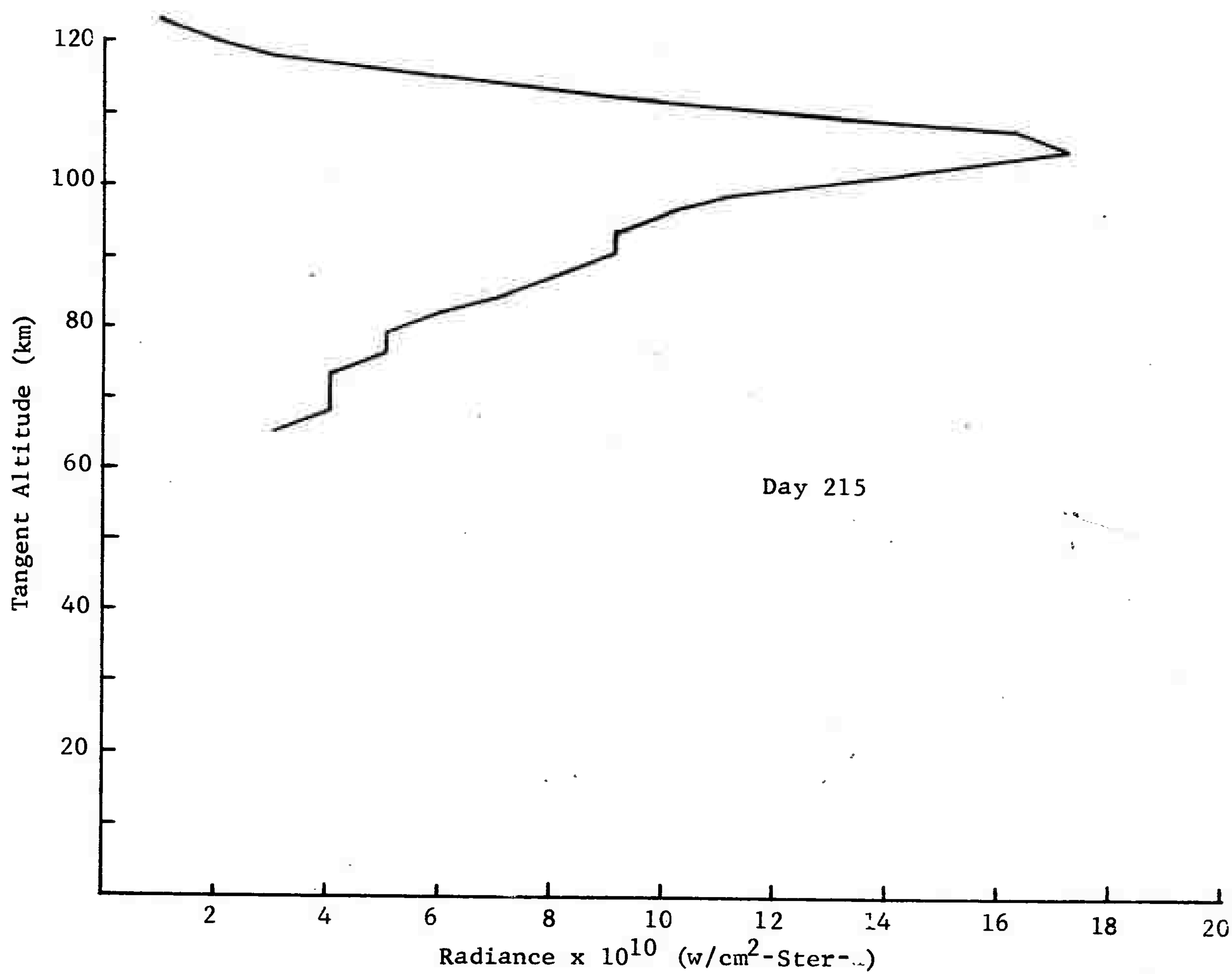

Fig. 19 Altitude Profile of 2380Å Nightglow

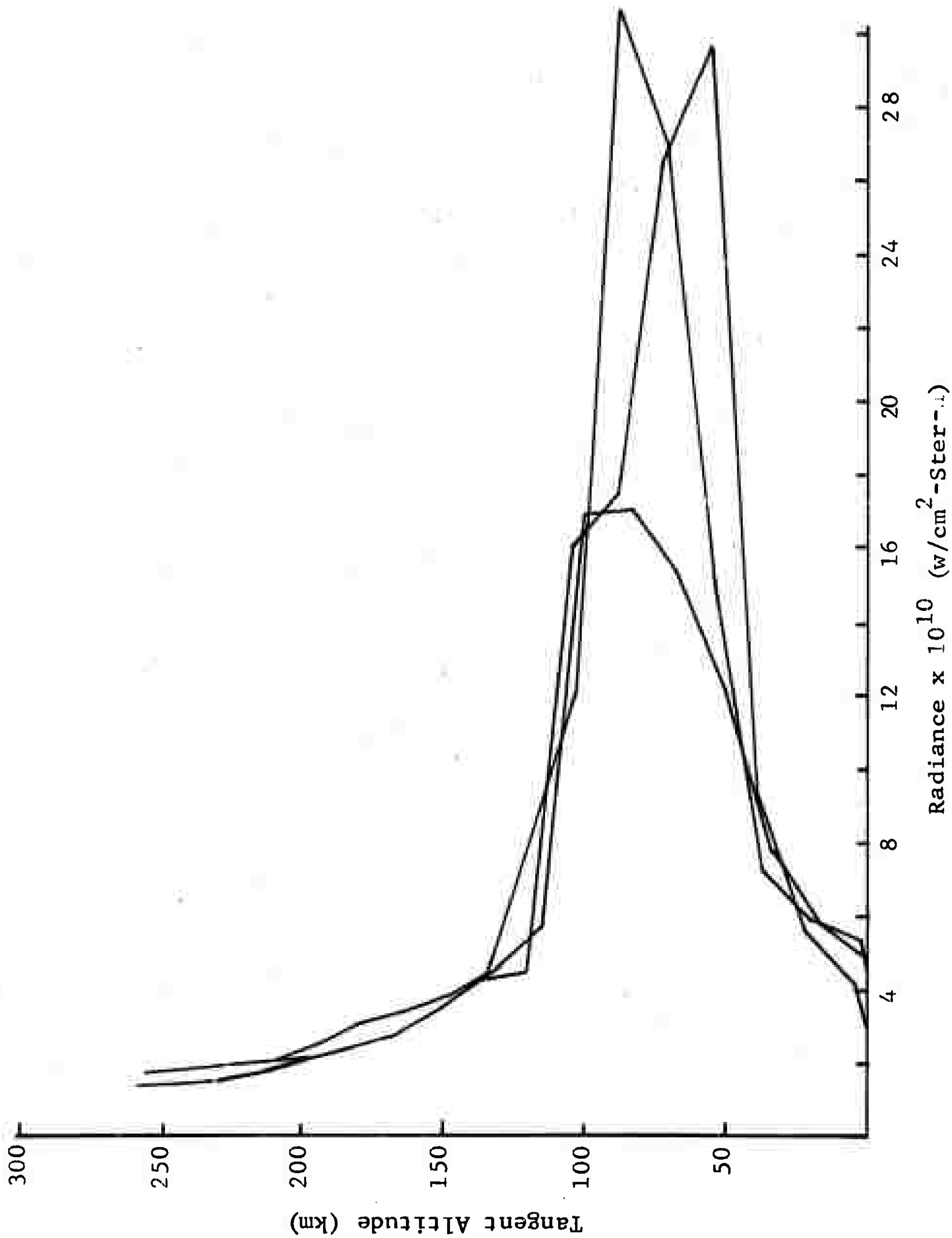

Fig. 20 Altitude Profile of the 2460Å Nightglow

SUMMARY AND CONCLUSIONS

All earth background measurements made with the OAO A-2's Wisconsin Experiment Package have been analyzed in terms of viewing geometry, and have been converted to equivalent earth's radiance. This information has been summarized and placed on a computer tape, the printout of which is given in Table 5.

Samples of the measurements were analyzed every three minutes when observing the dark earth, every minute for sunlit observations, and every 10 seconds for measurements of the earth's limb. The GMT time of the measurements, the tangent altitude, the solar, viewing, and scattering angles, the OAO and viewing intersection longitude and latitude, as well as the reduced radiance for seven of the filter combinations, are given for each point analyzed.

An analysis of the reduced data has provided the following conclusions:

1) The dayglow in the 1920Å spectral region is produced by the Rayleigh scattering of solar radiation. No significant radiation is produced above 100 kilometers.

2) In the 1300-1700Å region, the measurements support the theory that the radiation is produced by photoelectron excitation of nitrogen (N_2). This radiation has a peak in the emission rate near 175 kilometers.

3) The nightglow below 1700Å is quite low, less than 1.5×10^{-8} w/cm^2-ster-μ. There is some radiation produced by an unknown source, present in the 1920Å region. This radiation has a peak intensity near 70 kilometers.

4) The prominent feature of the UV nightglow is the radiation between 2500 and 3000Å that is thought to be the emissions from the Herzberg bands of molecular oxygen. This radiation shows a very sharp peak near 110 kilometers.

To complete the interpretation of these data, all measurements should be reduced into volume emission rates, and a detailed model of the radiation mechanisms should be developed. The reduction of

the nightglow measurements should be the simplest of these tasks. This involves inverting the limb measurements in a manner similar to that used by Robles and Hayes (Ref. 16). Reduction of the dayglow measurements is more complicated since the volume emission rates are dependent on the sun's position. The inversion is, therefore, not straightforward. A detailed model for the radiation mechanism, such as given by Eq. (13) for photoelectron excitation, is also required for a complete analysis of the measurements. Also needed are limb measurements at 1250, 1380, and 2380Å to complete the spectral picture of the ultraviolet earth background. Complete sets of measurements should be made at various times during the year to obtain seasonal variations in atmospheric emissions. Most observations made thus far with the OAO have been in the northern hemisphere. Therefore, additional measurements are required over various portions of the earth to obtain a global picture of the UV emissions. It appears that the best experiment for such measurements would be an imaging system with a large field of view and the comparable resolution of the WEP. This would provide significant information about local and global variations of the background.

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